Title
Distribution and burden of newly detected coronary artery calcium: Results from the Multi-Ethnic Study of Atherosclerosis.

Permalink
https://escholarship.org/uc/item/9c61g52d

Journal
Journal of cardiovascular computed tomography, 9(4)

ISSN
1934-5925

Authors
Alluri, Krishna
McEvoy, John W
Dardari, Zeina A
et al.

Publication Date
2015-07-01

DOI
10.1016/j.jcct.2015.03.015

Peer reviewed
Original Research Article

Distribution and burden of newly detected coronary artery calcium: Results from the Multi-Ethnic Study of Atherosclerosis

Krishna Alluri MDa,b, John W. McEvoy MB BChb, Zeina A. Dardari MSb, Steven R. Jones MD, Khurram Nasir MD, MPHb,c, Ron Blankstein MDd, Juan J. Rivera MD, MPHb,e, Arthur A. Agatston MD,e, Joel D. Kaufman MD, MPHf,g,h, Matthew J. Budoff MDi, Roger S. Blumenthal MD b, Michael J. Blaha MD, MPHb,*

a Department of Internal Medicine, UPMC McKeesport Hospital, McKeesport, PA, USA
b The Johns Hopkins Ciccarone Center for the Prevention of Heart Disease, Johns Hopkins Hospital, Carnegie 565A, 600 N. Wolfe Street, Baltimore, MD 21287, USA
c Center for Prevention and Wellness Research, Baptist Health Medical Group, Miami Beach, FL, USA
d Cardiovascular Division, Brigham and Women’s Hospital, Boston, MA, USA
e South Beach Preventive Cardiology Center, University of Miami, Miami, FL, USA
f Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA
g Department of Medicine, University of Washington, Seattle, WA, USA
h Department of Epidemiology, University of Washington, Seattle, WA, USA
i Division of Cardiology, Los Angeles Biomedical Research Institute at Harbor-UCLA, Torrance, CA, USA

ABSTRACT

Background: The transition from no coronary artery calcium (CAC) to detectable CAC is important, as even mild CAC is associated with increased cardiovascular events. We sought to characterize the anatomic distribution and burden of newly detectable CAC over 10-year follow-up.

Methods: We evaluated 3112 participants (mean age, 58 years; 64% female) with baseline CAC = 0 from the Multi-Ethnic Study of Atherosclerosis. Participants underwent repeat CAC testing at different time intervals (between 2–10 years after baseline) per the Multi-Ethnic Study of Atherosclerosis protocol. Among participants who developed CAC on a follow-up scan, we used logistic regression and marginal probability modeling to describe the coronary distribution and burden of new CAC by age, sex, and race after adjustment for cardiovascular risk factors and time to detection.

Keywords:
Coronary artery calcium
Left anterior descending artery

ARTICLE INFO

Article history:
Received 14 October 2014
Received in revised form 23 March 2015
Accepted 30 March 2015
Available online 7 April 2015

Conflicts of interest: Atherotech Diagnostics Lab and the Scientific Advisory Board at Atherotech Diagnostics Lab provided grant support (in kind, diagnostic testing). Steven Jones is a consultant to Sanofi and Regeneron. Other authors report no conflicts of interest.

Support: This research was supported by contracts N01-HC-95159, N01-HC-95160, N01-HC-95161, N01-HC-95162, N01-HC-95163, N01-HC-95164, N01-HC-95165, N01-HC-95166, N01-HC-95167, N01-HC-95168, and N01-HC-95169 from the National Heart, Lung, and Blood Institute and by grants UL1-TR-000040 and UL1-TR-001079 from National Center for Research Resources. This publication was developed under a STAR research assistance agreement, number RD831697 (MESA Air), awarded by the US Environmental Protection Agency (EPA). It has not been formally reviewed by the EPA. The views expressed in this document are solely those of the authors and the EPA does not endorse any products or commercial services mentioned in this publication.

* Corresponding author.
E-mail address: mblaha1@jhmi.edu (M.J. Blaha).

1934-5925/$ – see front matter © 2015 Society of Cardiovascular Computed Tomography. All rights reserved.
http://dx.doi.org/10.1016/j.jcct.2015.03.015
1. Introduction

Coronary artery calcium (CAC) is an imaging marker that is nearly pathognomonic for the presence of coronary atherosclerosis and can be detected using noncontrast cardiac CT. Indeed, CAC testing is specific for the presence of coronary atherosclerosis and highly sensitive for increasing burden of obstructive atherosclerotic coronary artery disease.

CAC is also highly effective for risk stratification of selected asymptomatic patients. For example, elevated CAC >300 is associated with a nearly 10-fold increased risk of adverse coronary events after multivariate adjustment. Equally important, the absence of CAC in asymptomatic adults is associated with a low mortality rate of 1% over 10 years. Even mildly elevated CAC denotes risk, as patients with CAC scores between 1 and 10 have a 2- to 3-fold increased risk of cardiovascular adverse events and death compared with those with CAC = 0.

Given these prognostic differences, a clinical finding of zero vs nonzero CAC has important implications for clinical decision making, including the decision to treat risk conditions with lifestyle vs pharmacotherapy. Thus, there is a great deal of interest in studying the transition from zero to nonzero CAC. However, little is known about the characteristics of newly detected CAC, including its typical coronary distribution and burden.

To fill this gap, we used longitudinal CAC data from the Multi-Ethnic Study of Atherosclerosis (MESA) to describe the imaging characteristics related to the transition from zero to nonzero CAC. In particular, we asked the following questions: (1) At the first detection of new CAC, does CAC occur more commonly in 1 vessel vs multiple vessels? (2) Does new CAC preferentially occur in particular coronary arteries? (3) At the first detection of new CAC, what is the CAC score burden? (4) Does the coronary distribution and burden of new CAC vary by age, sex, or race?

2. Methods

2.1. The Multi-Ethnic Study of Atherosclerosis

MESA was designed to study the prevalence, risk factors, and progression of subclinical cardiovascular disease in individuals without known cardiovascular disease. MESA was designed to study the prevalence, risk factors, and progression of subclinical cardiovascular disease in individuals without known cardiovascular disease. MESA was designed to study the prevalence, risk factors, and progression of subclinical cardiovascular disease in individuals without known cardiovascular disease.

Results: A total of 1125 participants developed detectable CAC during follow-up with a mean time to detection of 6.1 ± 3 years. New CAC was most commonly isolated to 1 vessel (72% of participants), with the left anterior descending artery (44% of total) most commonly affected followed by the right coronary (12%), left circumflex (10%), and left main (6%). These patterns were similar across age, sex, and race. In multivariate models, residual predictors of multivessel CAC (28% of total) included male sex, African American or Hispanic race, hypertension, obesity, and diabetes. At the first detection of CAC >0, burden was usually low with median Agatston CAC score of 7.1 and <5% with CAC scores >100.

Conclusion: New-onset CAC most commonly involves just 1 vessel, occurs in the left anterior descending artery, and has low CAC burden. New CAC can be detected at an early stage when aggressive preventive strategies may provide benefit.

© 2015 Society of Cardiovascular Computed Tomography. All rights reserved.
provide a more accurate point estimate of the amount of calcium present. Carr et al\textsuperscript{12} have reported details of the methods used by MESA for CT scanning and interpretation. The amount of calcium was quantified with the Agatston scoring method.\textsuperscript{13} When CAC was detected on CT images, its location was ascertained to left main (LM), left anterior descending (LAD), left circumflex (LCX), or right coronary arteries (RCA). Data regarding segmental distribution of CAC within individual coronary arteries were not available for our analysis. The kappa statistic for agreement on presence of any CAC was 0.92.

2.4. Risk factor assessment

As part of the baseline examination, study teams at each of the 6 centers collected information on cardiovascular risk factors. Total cholesterol, high-density lipoprotein cholesterol (HDL-C), triglyceride, and glucose levels were measured in blood samples obtained after a 12-hour fast. The low-density lipoprotein cholesterol (LDL-C) level was determined with the Friedewald equation.\textsuperscript{14} Hypertension (HTN) status was classified according to the Seventh Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure.\textsuperscript{15} Diabetes mellitus (DM) status was classified according to American Diabetes Association 2003 criteria.\textsuperscript{16} Obesity (body mass index [BMI] \( \geq 30 \) kg/m\(^2\)) was classified according to the World Health Organization classification. Medication use was determined by a questionnaire. Smoking status was classified as never smoker, former smoker, and current smoker. Never smoker was defined as lifetime consumption of \(< 100\) cigarettes and current smoker was defined as smoking within 30 days as per the National Cholesterol Education Program—Adult Treatment Panel III.\textsuperscript{17}

3. Statistical analysis

Baseline characteristics of the overall study population (\( N = 3112 \)) are presented in aggregate and by incident CAC status (follow-up CAC = 0 vs follow-up CAC >0). Continuous variables are presented as mean \( \pm \) standard deviation, whereas categorical variables are presented as total number and the proportion of the total. Differences between 2 groups were compared using the chi-square analysis for categorical variables and using 2-sample \( t \) tests for normally distributed continuous variables. Kruskal-Wallis equality of population rank tests were used to compare distributions between groups of non-normally distributed continuous variables.

The remainder of the analyses focused on patients with newly detected CAC during follow-up (\( N = 1125 \)). To characterize the anatomic distribution of new-onset CAC over time in MESA, we described new-onset CAC as occurring in a single vessel (LM, RCA, LAD, LCX) or in multiple vessels (2, 3, or 4 vessels). We then calculated the adjusted marginal probabilities of each CAC distribution pattern using the “margins” command in STATA version 13 (Stata Corp, College Station, TX, USA). Probabilities were postestimated following a multivariate logistic regression model adjusted for the following variables: age, race, sex, time to CAC >0 detection, HTN status, household income (a measure of socioeconomic status), smoking status, diabetes status, LDL-C >160 mg/dL, use of lipid-lowering medications, and obesity (BMI \( \geq 30 \) kg/m\(^2\)). Time to CAC >0 detection was included in the models to account for the effect of the differential time between scans of individual participants in MESA. Marginal probabilities should not be considered the absolute prevalence of CAC by particular attribute (ie, race) but rather the residual differences in new-onset CAC that remain within that attribute after adjusting for other risk factors.

To characterize the burden of newly detected CAC over time in MESA, we assigned individuals to distinct CAC score categories (1–10, 11–100, and >100) as well as summarized the median Agatston score at the first detection of CAC. Using the chi-square analysis and Kruskal-Wallis testing, we assessed for differences in CAC burden by anatomic distribution (individual vessel involvement in those with single vessel CAC), as well as for differences in CAC burden between single-vessel and multivessel CAC. Statistical analysis was performed using Stata 13. A 2-sided \( P \) value of \(< .05 \) was used to indicate statistical significance.

4. Results

4.1. Baseline characteristics

Table 1 summarizes the characteristics of our overall study sample. A total of 3112 subjects were included in the study. Average age was 57.9 \( \pm \) 9 years and approximately 64% were female. The race distribution of our sample includes 34% White, 12% Chinese American, 31% Black, and 23% Hispanic.

Approximately 1125 subjects of our study sample (36%) developed new CAC with a mean time to detection of 6.1 \( \pm \) 3.4 years. The percentage of subjects who developed new CAC at visit 2, 3, 4, and 5 were 11%, 21%, 22%, and 34%, respectively. The mean time to detection of new CAC was shorter in males (5.9 \( \pm\) 3.4 years) compared to females (6.3 \( \pm\) 3.4 years) and did not differ among subjects from different race groups.

New CAC was more prevalent among males, and the mean age of these subjects was higher when compared to subjects who did not develop CAC on follow-up scans. There was higher prevalence of HTN, DM, and smoking among subjects with new CAC compared to those with CAC = 0. Subjects with new CAC demonstrated significantly higher systolic blood pressure, diastolic blood pressure, BMI, cholesterol, LDL-C, Framingham risk score, cardiovascular disease risk score and lower HDL-C compared to CAC = 0 group. Baseline use of lipid-lowering and antihypertensive medications was significantly higher in subjects with new CAC. Participants with new CAC also had more number of follow-up CAC scans compared to CAC = 0 group (Table 1).

4.2. Coronary distribution of new CAC

New CAC most commonly involved 1 vessel (unadjusted probability of 72%). Over the entire range of time from the baseline scan, 1 vessel involvement remained the most
common presentation of new CAC (Fig. 1A). Among subjects with 1 vessel involvement, the LAD was the most common vessel affected, and this pattern continued over the entire range of time from baseline scans. LAD involvement was followed in order of frequency by the RCA, LCX, and LM coronary arteries (Table 2; Fig. 1B).

Multivessel involvement of new CAC seen was 28% of subjects. With increased time from baseline scan, there was increased frequency of multivessel involvement of new CAC (15% at visit 2 vs 35% at visit 5). However, 1 vessel involvement of new CAC was the most common pattern even at visit 5, which occurred nearly 10 years after baseline scan (Table 2; Fig. 1A).

4.3. Association between risk factors and distribution of new CAC

Among all age, sex, and race groups, single-vessel CAC with LAD involvement was the most common phenotype. With increase in age, there was increased multivessel involvement of new CAC, which peaked in the age group of 65 to 74 years; however, single-vessel CAC with LAD involvement remained the most common presentation even in this age group (Table 3). Males compared to females and Hispanic and Black compared to White and Chinese were associated with higher residual probability of multivessel new CAC involvement after multivariate adjustment (Table 3).

The residual probability of multivessel new CAC involvement was significantly higher in subjects with HTN, DM, and obesity after adjustment for the remaining risk variables. In current smokers and in subjects with LDL-C ≥160 mg/dL and total cholesterol-to-HDL-C ratio >3, there was no increased residual probability of multivessel new CAC involvement (Table 4).

4.4. Burden of new CAC

Among subjects with new CAC, 52% had CAC scores of 1 to 10, 44% had CAC scores of 11 to 100, and 4% had CAC scores >100. CAC burden was higher among subjects who developed CAC in visit 4 and 5 compared to those in visit 2 and 3 (Supplementary Table 1). The burden of new-onset CAC was significantly higher in subjects with multivessel CAC compared with those with 1 vessel involvement. Of those subjects with new CAC in a single vessel, 65% had CAC scores of 1 to 10, 34% had CAC scores of 11 to 100, and 1% had CAC scores >100. Of those subjects with multivessel involvement at the time of new CAC detection, 20% had CAC scores of 1 to 10, 68% had CAC scores of 11 to 100, and 12% had CAC scores >100 (Table 5).

The median CAC score in subjects with single-vessel and multivessel involvement was 5.9 and 26.2, respectively. Among subjects with 1 vessel involvement, CAC was significantly higher in LAD and LM followed by RCA and then LCX (Table 5). There was no difference in CAC burden by age, sex, and race groups. Subjects with new-onset advanced CAC (CAC >100) were equally distributed among all age, sex, and race groups (Supplementary Table 2).
5. Discussion

Although $CAC = 0$ is associated with excellent prognosis, presence of even mild $CAC$ is associated with an increased risk of adverse events, and little is known about the transition from $CAC = 0$ to initially detectable $CAC > 0$. In MESA, we found that new $CAC$ was most commonly found in a single vessel at first detection, with this pattern persisting among subjects of all age, sex, and race groups. Among the individual coronary arteries, the LAD was the most likely location for new $CAC$. Multivessel involvement of new $CAC$ was more likely among males, Hispanics, Blacks, and in subjects with HTN, DM, and obesity. At the first detection of new $CAC$, the $CAC$ burden was low, with $<5\%$ of subjects having a $CAC$ score of $>100$. This is the first community-based study to describe the $CAC$ distribution and $CAC$ score burden at the initial detection of new $CAC$.

5.1. Prior studies on distribution of coronary atherosclerosis

The prevalent distribution of atherosclerosis in the coronary arteries has been described in prior cross-sectional studies. Pathological studies have shown that the prevalence and burden of atherosclerosis was higher in LAD, followed by RCA and then LCX. However, the differences have not been dramatic and some studies even observed roughly equal frequency of atherosclerosis in the LAD and the RCA and lower frequency in the LCX. Tuzcu et al. using intravascular ultrasonography, showed that there was no statistically significant difference in distribution of lesions within different coronary arteries, although there was a trend toward higher prevalence in LAD and lower prevalence within LCX. It has been hypothesized that the preferential development of atherosclerosis in LAD can be due to the difference in the flow patterns in various anatomic locations of coronary arteries. To our knowledge, there are no longitudinal studies describing the geographical incidence of atherosclerosis in the coronary arteries. Using $CAC$ as a marker of atherosclerosis, we showed that incidence of new $CAC$ is higher in LAD compared to RCA and LCX. However, we cannot rule out the possibility that calcium deposition occurs earlier in atherosclerotic lesions in LAD compared with lesions in other coronary arteries (RCA, LCX, and LM).

5.2. Comparison to prior $CAC$ studies

In our analysis, we observed that traditional coronary heart disease risk factors including HTN, DM, smoking, high BMI, and high LDL levels are independently associated with development of new $CAC$. Similar results were seen in

![Fig. 1](image)

**Table 2 — $CAC$ distribution at the first detection of $CAC > 0$.**

<table>
<thead>
<tr>
<th>Distribution of new-onset $CAC$</th>
<th>All visits (N = 1125)</th>
<th>Visit 2’ (N = 170)</th>
<th>Visit 3’ (N = 305)</th>
<th>Visit 4’ (N = 150)</th>
<th>Visit 5’ (N = 500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single vessel</td>
<td>72% (807)</td>
<td>85% (144)</td>
<td>74% (226)</td>
<td>75% (113)</td>
<td>65% (324)</td>
</tr>
<tr>
<td>LAD</td>
<td>44%</td>
<td>57%</td>
<td>41%</td>
<td>44%</td>
<td>42%</td>
</tr>
<tr>
<td>RCA</td>
<td>12%</td>
<td>12%</td>
<td>14%</td>
<td>14%</td>
<td>10%</td>
</tr>
<tr>
<td>LCX</td>
<td>10%</td>
<td>12%</td>
<td>13%</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>LM</td>
<td>6%</td>
<td>4%</td>
<td>6%</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>Multivessel</td>
<td>28% (318)</td>
<td>15% (26)</td>
<td>26% (79)</td>
<td>25% (37)</td>
<td>35% (176)</td>
</tr>
<tr>
<td>2 vessel</td>
<td>20%</td>
<td>12%</td>
<td>20%</td>
<td>18%</td>
<td>24%</td>
</tr>
<tr>
<td>3 or 4 vessel</td>
<td>8%</td>
<td>3%</td>
<td>6%</td>
<td>7%</td>
<td>11%</td>
</tr>
</tbody>
</table>

$CAC$, coronary artery calcium; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main artery; N, number of subjects; RCA, right coronary artery.

* Visits 2, 3, 4, and 5 include subjects who had detectable $CAC$ on a follow-up scan at mean $1.7 \pm 0.3$, $3.2 \pm 0.4$, $4.9 \pm 0.5$, and $9.7 \pm 0.6$ years, respectively, after baseline scan.
Table 3 — Multivariable-adjusted residual probability (%) of newly detected CAC distribution patterns by age, sex, and race.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Single vessel LAD</th>
<th>Single vessel RCA</th>
<th>Single vessel LCX</th>
<th>Single vessel LM</th>
<th>Multivessel P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–54</td>
<td>48</td>
<td>14</td>
<td>9</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>55–64</td>
<td>45</td>
<td>14</td>
<td>7</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>65–74</td>
<td>39</td>
<td>9</td>
<td>10</td>
<td>8</td>
<td>34</td>
</tr>
<tr>
<td>75–84</td>
<td>53</td>
<td>6</td>
<td>13</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>49</td>
<td>11</td>
<td>9</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Male</td>
<td>41</td>
<td>13</td>
<td>8</td>
<td>7</td>
<td>31</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>50</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Chinese</td>
<td>54</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Black</td>
<td>41</td>
<td>13</td>
<td>9</td>
<td>6</td>
<td>31</td>
</tr>
<tr>
<td>Hispanic</td>
<td>39</td>
<td>12</td>
<td>11</td>
<td>5</td>
<td>33</td>
</tr>
</tbody>
</table>

CAC, coronary artery calcium; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main artery; RCA, right coronary artery.

Predicted probabilities adjusted for age categories, race categories, sex, time to CAC >0 detection, hypertension, household income, smoking status, use of any lipid-lowering medications, diabetes, LDL-C >160, and obesity (body mass index >30 kg/m²).

* P value is for single vessel vs multivessel involvement of CAC. Refer to Table 1 for sample size of each category.

Previous studies have described the variation of newly detected CAC by age, sex, and race groups. However, to our knowledge, there are no longitudinal studies defining the origin and demographic distribution of new CAC in coronary arteries. Therefore, we have extended prior work by demonstrating that new CAC most commonly involves the LAD across all age, sex, and race groups.

The burden of new-onset CAC has been described in some of the studies mentioned previously, and in our study, 52% had a CAC score of 1 to 10, 44% had a CAC score of 11 to 100, and 4% had a CAC score >100. Our study has a higher burden of new-onset CAC compared to the study by Gopal et al. (approximately 69% had CAC score of 1–9, 26% had CAC score of 10–50, and 5% had CAC score >50) and the burden is even less in the study by Koulaouzidis et al. (approximately 84% had CAC score of 1–9, 14% had CAC score of 10–50, and 2% had CAC score >50). Our study has an older patient population and higher traditional risk factor burden compared to prior studies, perhaps also explaining our observed burden of new-onset CAC. In addition, lack of annual scanning resulting in increased lag period between the scans can be a contributing factor for the higher CAC burden at first detection in our study.

Cross-sectional burden of CAC among different age, sex, and race groups has been described in previous studies. However, no studies have investigated the demographic variation of newly detected CAC. A striking finding from our study is that there is no difference in the burden of new CAC by age, sex, and race group.

5.3. Clinical implications

To our knowledge, there are no formal guidelines on repeat CAC testing for routine quantification of CAC progression; however, prior data suggest that a repeat scan in 4 to 5 years appears reasonable in individuals with a baseline score of CAC = 0. We have shown that at the first detection of CAC >0, the burden is usually low (<100). This suggests that people rarely convert from CAC = 0 to high CAC scores, which is important because high scores are associated with increased event rates. Therefore, repeat scans to identify subjects with CAC >0 may allow detection while scores are still low and with adequate time to initiate aggressive preventive therapies. Whether this strategy can reduce cardiac events warrants further study. Our data also have implications for readers of cardiac CT scans, allowing readers to be familiar with the most common patterns of new-onset CAC.

6. Limitations

The principal limitation of this study is that annual CAC scanning was not performed. The timing of CAC scans was not specified per the MESA protocol, which did not call for...
every participant to have scans at each follow-up visit. Therefore, it is impossible to know when exactly new CAC was developed, and our data should be considered time to first CAC detection rather than strict time to CAC incidence. However, the patterns and implications we have described should still hold, as lack of annual scanning would result in overestimation of the incidence of multivessel CAC and of CAC score burden at the first CAC detection.

In addition, we did not model change in risk factor or change in medication use over the course of the study. It is possible that changing behaviors or therapies may have had an effect on new-onset CAC. As the Agatston method was used to quantify CAC in our study, there is a possibility that certain lesions, especially those with low-density calcium and small areas of calcium (<1 mm²) can be missed, which could influence our data. In our study, we do not have data regarding CAC distribution in different segments within individual coronary arteries. CAC analysis between coronary artery segments of similar length can provide a better picture of the segments with high chances of developing new CAC. Finally, although we demonstrated the coronary distribution and burden of new CAC, we did not study their prognostic implications. Studies on the prognostic significance of coronary distribution in MESA are forthcoming.36

### Acknowledgments

The authors thank the other investigators, the staff, and the participants of the MESA study for their valuable contributions. A complete list of participating MESA investigators and institutions can be found at [http://www.mesa-nhlbi.org](http://www.mesa-nhlbi.org).

### References


---

Table 5  – CAC burden at the first detection of CAC > 0.

<table>
<thead>
<tr>
<th>Vessel affected</th>
<th>CAC 1–10</th>
<th>CAC 11–100</th>
<th>CAC &gt;100</th>
<th>P value*</th>
<th>Median CAC score (IQR)</th>
<th>P value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population (N = 1125)</td>
<td>52%</td>
<td>44%</td>
<td>4%</td>
<td>&lt;.001</td>
<td>9.4 (3.7–22.9)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Single vessel (N = 807)</td>
<td>65%</td>
<td>34%</td>
<td>1%</td>
<td>.01</td>
<td>5.9 (2.6–14.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>LAD (N = 500)</td>
<td>61%</td>
<td>38%</td>
<td>1%</td>
<td>6.8 (2.8–14.9)</td>
<td>5.6 (2.3–12.6)</td>
<td>3.7 (1.9–8.8)</td>
</tr>
<tr>
<td>RCA (N = 133)</td>
<td>68%</td>
<td>31%</td>
<td>1%</td>
<td>7.0 (2.8–16.8)</td>
<td>26.2 (12.6–54.7)</td>
<td>7.0 (2.8–16.8)</td>
</tr>
<tr>
<td>LM (N = 67)</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>7.0 (2.8–16.8)</td>
<td>26.2 (12.6–54.7)</td>
<td>7.0 (2.8–16.8)</td>
</tr>
<tr>
<td>Multivessel (N = 318)</td>
<td>20%</td>
<td>68%</td>
<td>12%</td>
<td>&lt;.001</td>
<td>54.7 (12.6–54.7)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

CAC, coronary artery calcium; IQR, interquartile range; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main artery; N, number of subjects; RCA, right coronary artery.

* P value is for comparison of CAC burden among individual coronary arteries (LAD vs RCA vs LCX vs LM) as well as between single-vessel vs multivessel involvement.

† P value is for comparison of median CAC among individual coronary arteries (LAD vs RCA vs LCX vs LM) as well as between single-vessel vs multivessel involvement.


30. Lubansky MS, Vanhecke TE, Chinnaiyan KM, Franklin BA, McCullough PA. Subclinical coronary atherosclerosis identified by coronary computed tomographic angiography in asymptomatic morbidly obese patients. Heart Int. 2010;5:e15.


### Supplementary Table 1 – CAC burden according to visit.

<table>
<thead>
<tr>
<th>CAC burden</th>
<th>All visits (N = 1125)</th>
<th>Visit 2* (N = 170)</th>
<th>Visit 3* (N = 305)</th>
<th>Visit 4* (N = 150)</th>
<th>Visit 5* (N = 500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAC 1–10</td>
<td>52%</td>
<td>68%</td>
<td>67%</td>
<td>50%</td>
<td>39%</td>
</tr>
<tr>
<td>CAC 11–100</td>
<td>44%</td>
<td>31%</td>
<td>31%</td>
<td>47%</td>
<td>55%</td>
</tr>
<tr>
<td>CAC &gt;100</td>
<td>4%</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
<td>6%</td>
</tr>
</tbody>
</table>

CAC, coronary artery calcium.

* Visits 2, 3, 4, and 5 include subjects who had a follow-up scan at mean 1.7 ± 0.3, 3.2 ± 0.4, 4.9 ± 0.5, and 9.7 ± 0.6 years, respectively, after baseline scan.

### Supplementary Fig. 1 – Percentage of participants with CAC scanning at each visit in MESA. *Visit 1 is the initial baseline scan consisted of entire study population which includes 3112 participants. Visit 2, 3, 4, and 5 were at mean 1.7 ± 0.3, 3.2 ± 0.4, 4.9 ± 0.5, and 9.7 ± 0.6 years, respectively, after baseline scan and consisted of 1522, 1425, 677, and 1461 participants at each visit, respectively.

### Supplementary Table 2 – CAC burden at the first detection of CAC > 0 stratified by age, sex, and race groups.

<table>
<thead>
<tr>
<th>Factor</th>
<th>CAC 1–10 (N = 588)</th>
<th>CAC 11–100 (N = 492)</th>
<th>CAC &gt;100 (N = 45)</th>
<th>Median CAC (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–54</td>
<td>52</td>
<td>44</td>
<td>4</td>
<td>9.4 (3.3–22.4)</td>
</tr>
<tr>
<td>55–64</td>
<td>50</td>
<td>44</td>
<td>6</td>
<td>10.0 (3.7–25.2)</td>
</tr>
<tr>
<td>65–74</td>
<td>54</td>
<td>42</td>
<td>4</td>
<td>8.4 (3.5–21.1)</td>
</tr>
<tr>
<td>75–84</td>
<td>56</td>
<td>44</td>
<td>0</td>
<td>6.8 (3.0–20.8)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>51</td>
<td>45</td>
<td>4</td>
<td>9.8 (3.7–23.8)</td>
</tr>
<tr>
<td>Male</td>
<td>54</td>
<td>42</td>
<td>4</td>
<td>8.7 (3.3–21.3)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>53</td>
<td>43</td>
<td>4</td>
<td>8.8 (3.7–20.6)</td>
</tr>
<tr>
<td>Chinese</td>
<td>47</td>
<td>48</td>
<td>5</td>
<td>11.2 (4.7–22.4)</td>
</tr>
<tr>
<td>Black</td>
<td>52</td>
<td>44</td>
<td>4</td>
<td>9.4 (3.1–28.0)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>53</td>
<td>43</td>
<td>4</td>
<td>8.9 (3.3–23.1)</td>
</tr>
</tbody>
</table>

CAC, coronary artery calcium; IQR, interquartile range.

CAC burden among subjects from different age, sex, and race groups represented as percentage (%) of patients in different CAC groups (CAC 1–10, CAC 11–100 and CAC >100).