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Disparities in statin use following identification of coronary artery calcium

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ABSTRACT

Background: Coronary artery calcium (CAC) scoring is a useful tool for risk stratification in asymptomatic individuals, and current clinical practice is to utilize statins in individuals with CAC. A growing body of research has aimed to identify and mitigate health disparities and their relation to cardiovascular disease (CVD) risk. Likewise, studies have highlighted social determinants of health (SDOH) that contribute to health disparities in CVD.

Objectives: We aimed to evaluate whether disparities exist with regards to statin use after identification of CAC within the Multi-Ethnic Study of Atherosclerosis (MESA).

Methods: The associations between race/ethnicity, age, sex, primary language, and an aggregate SDOH score (calculated using previously defined methods) with statin use at short- and long-term follow-up were evaluated in logistic regression models with adjustment for traditional CVD risk factors in individuals with baseline CAC>0 without baseline statin use.

Results: In the overall cohort, 3416 participants had CAC = 0, 1794 CAC 1–99, 757 CAC 100–300, and 847 CAC>300 AU Mean age was 62 (10.2) years, 53 % (n = 3601) were women, 38.5 % (n = 2622) were non-Hispanic White, 27.8 % (n = 1892) were non-Hispanic Black, 22.0 % (n = 1892) were Hispanic and 11.8 % (n = 1892) were Chinese. At short-term follow up (median 1.6 years, n = 2665), those with a higher SDOH score (worse burden) (OR 0.39, 95 % CI 0.16–0.91), Hispanic (OR 0.59, 95 % CI 0.40–0.85) and Spanish speaking individuals (OR 0.51, 95 % CI 0.30–0.83) were less likely to report statin use following CAC identification. At long-term follow up (median 9.4 years, n = 2533), Black individuals (OR 0.71, 95 % CI 0.52–0.96), Chinese (OR 0.58, 95 % CI 0.39–0.86) and Chinese speaking individuals (OR 0.50, 95 % CI 0.33–0.76) were also less likely to report statin use following CAC identification, and a trend was noted for SDOH score (OR 0.53, 95 % CI 0.26–1.09).

Conclusions: This study identifies disparities in statin use by race/ethnicity, language, and social determinants of health after identification of CAC. While CAC is an effective tool for identifying atherosclerosis in asymptomatic individuals, more equitable use of subsequent therapy is needed.

1. Introduction

Cardiovascular disease (CVD) remains the leading cause of mortality in the United States. Despite advances in treatment and prevention, disparities persist in both CVD management and outcomes, particularly among different racial/ethnic groups, women, and those facing socioeconomic disadvantages [1–5]. A growing body of research has aimed to identify and mitigate these health disparities in CVD and studies have highlighted social determinants of health (SDOH) that contribute to health disparities in CVD. For instance, within the Multi-Ethnic Study of Atherosclerosis (MESA) cohort, increasing social disadvantage has been

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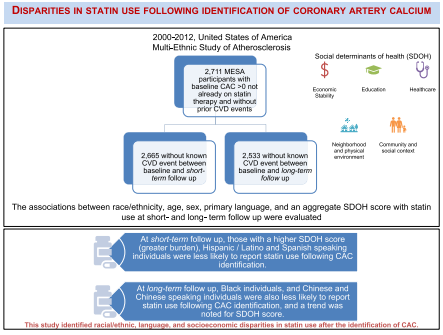
associated with more prevalent cardiovascular risk factors, inflammation, and incident cardiovascular disease [4]. Likewise, within this cohort, experiences of discrimination have been associated with increased risk of incident diabetes [6].

Coronary artery calcium (CAC) scoring is an effective tool for evaluating subclinical coronary atherosclerosis and to predict future coronary heart disease (CHD) events [7]. Its role in screening has evolved over the last three decades since the Agatston score was first described in 1990. CAC scoring is associated with higher likelihood of initiation or continuation of both pharmacotherapies and lifestyle interventions for prevention of cardiovascular disease [8]. Several international guidelines recommend the initiation of statin therapy on the



Central Illustration.

basis of CAC scoring, particularly with CAC>100, including the 2017 Society of Cardiovascular Computed Tomography (SCCT) expert consensus [9], the 2019 American College of Cardiology/American Heart Association (ACC/AHA) Guidelines on Primary Prevention of Cardiovascular Disease [10], the 2021 National Lipid Association scientific statement [11], and the 2021 Canadian Cardiovascular Society (CCS) guidelines [12,13].Multiple guidelines also favor statin therapy with the presence of any CAC, including the SCCT statement, the ACC/AHA guidelines, particularly for individuals over 55, and the CCS guidelines [10]. For a score of 0, withholding statin therapy can be considered, unless individuals have diabetes, family history of premature CHD, or smoke cigarettes [10]. Studies have also demonstrated that individuals with CAC are more likely to benefit from statins, which were associated with reduced risk of major adverse cardiovascular events in those patients with CAC but not those without CAC [14]. To date, studies have demonstrated disparities with regards to obtaining CAC scoring, noting patients from lower income locations are less likely to pursue CAC testing [15].

While there are noted disparities in cardiovascular management generally, and in obtaining CAC scoring, it is unclear what disparities exist in patient management after identification of the presence of CAC. Given the increased utilization of CAC testing for risk stratification, we aimed to evaluate disparities in statin use after identification of CAC by race/ethnicity, language and social determinants of health (SDOH).

2. Methods

2.1. Study population

We included data from participants in MESA, a community-based prospective cohort study of individuals without known CVD aged 45 to 84 years old at enrollment. Participants were from one of 4 self-identified racial/ethnic groups (Non-Hispanic White, Black, Hispanic, and Chinese) among 6 sites in the United States. Enrollment occurred between 2000–2002 with serial follow-up exams. For the current analysis, all participants with baseline CAC >0 who were not already on statin therapy were included. The institutional review boards at each center approved the study and participants provided written informed consent. Further details and study design for MESA have been described elsewhere [16].

2.2. Covariates and outcomes

For all participants, data on demographics, cardiovascular risk factors, and social determinants of health were collected utilizing standardized questionnaires, physical examinations and laboratory assessments at the baseline exam. Hypertension was defined by the Joint National Committee on Prevention, Detection, and Treatment of High Blood Pressure (JNC VI) criteria [17]. Diabetes was defined by 2003 American Diabetes Association fasting criteria [18]. Current smoking was self-reported. Use of anti-hypertensive medication and statin were also self-reported. Systolic blood pressure was recorded as the average of multiple seated measurements. Fasting blood samples were obtained for laboratory measurements including total cholesterol. CAC was measured utilizing electron beam computed tomography or multi-detector-row helical computed tomography using the Agatston method, as previously described [19]. All participants underwent CAC scoring at baseline, with follow-up assessments at exams 2 or 3 and exam 5.

The primary predictors of interest were race/ethnicity, primary language and aggregate SDOH score. Primary outcomes of interest included self-reported statin use at follow-up (short-term follow-up at exam 2, 2002–2004, and long-term follow-up at exam 5, 2010–2012).

2.3. Aggregate SDOH index

An aggregate SDOH index score was created and modeled after a previous study within MESA [4]. In line with the previous study, the score was created from 14 components which covered the 5 general domains described in the Healthy People 2030 initiative (Fig. 1) [20]. Utilizing SDOH data collected from questionnaires at the initial MESA visits, a list of 14 items was created. Several of the 14 items were created from a composite score of items. Each of the 14 components were dichotomized and attributed a score of 1 if adverse or 0 otherwise. Since not all of the 5 domains were comprised of the same number of items, the domains were each weighted equally. Each domain therefore had a total score of 0.2, and scores were then summed to define a total SDOH aggregate index ranging from 0 to 1, with higher scores indicating greater SDOH disadvantage. Participants were then divided into tertiles based on SDOH score.

2.4. Statistical analysis

Baseline demographics were compared by CAC stratum (0, 1–99, 100–300, >300 AU). Continuous variables were compared using ANOVA and categorical variables were compared using Chi-square testing. The prevalence of statin use at short- and long-term follow-up was evaluated by race/ethnicity, primary language, and tertile of SDOH score and compared using Chi-square testing.

The associations between the predictors of interest (race/ethnicity, primary language, aggregate SDOH score) and statin use at short- and long-term follow-up were evaluated in logistic regression models with adjustment for traditional CVD risk factors (age, sex, body mass index [BMI], systolic blood pressure [SBP], total cholesterol, high-density lipoprotein-cholesterol [HDL-C], diabetes, smoking status, use of anti-hypertensive medications). Additional analyses among individuals with CAC $\geq$100 or $\geq$300 AU were performed. A p-value <0.05 was considered statistically significant. All analyses were conducted in R (version 4.3.1).

3. Results

3.1. Population characteristics

MESA includes 6814 participants. Those with CAC = 0 (n = 3416) and with baseline statin use (n = 687) were excluded. For the short-term analysis, those with a CVD event between baseline and follow-up were excluded (n = 46), resulting in a sample of 2665 participants (49 were missing covariates for the SDOH score, leaving 2616 participants for this analysis). For the long-term analysis, those with a CVD event between baseline and follow-up were excluded (n = 178), resulting in a sample of 2533 participants (2488 for the SDOH score analysis) (Fig. 2).

In the overall cohort, 3416 had CAC = 0, 1794 CAC 1–99, 757 CAC 100–300, and 847 CAC >300 AU Mean age was 62 (10.2) years, 53 % (n = 3601) were women, 38.5 % (n = 2622) were non-Hispanic White, 27.8 % (n = 1892) were non-Hispanic Black, 22.0 % (n = 1892) were Hispanic and 11.8 % (n = 1892) were Chinese. With increasing CAC score, there was increasing burden of cardiovascular risk factors including age, male sex, hypertension, and diabetes (all $p < 0.001$). With increasing CAC score, participants were more often White and English-speaking ($p < 0.001$). There was also increasing prevalence of statin use at baseline and follow-up and decreasing SDOH score ($p < 0.001$) (Table 1).

When stratified by race/ethnicity, White individuals most frequently reported statin use at short-term follow-up (12.44 %), followed by Black (12.29 %), Hispanic (10.62 %) and Chinese (10.10 %) individuals (Fig. 3). At long-term follow-up, Hispanic individuals most frequently reported statin use (39.58 %), followed by White (37.48 %), Black (33.24 %) and Chinese (27.98 %) individuals ($p < 0.001$). By language, the greatest prevalence of statin use at short-term follow-up was among English (12.23 %) followed by Chinese (10.93 %) and Spanish speakers

Fig. 1. Components of the SDOH Aggregate Score.

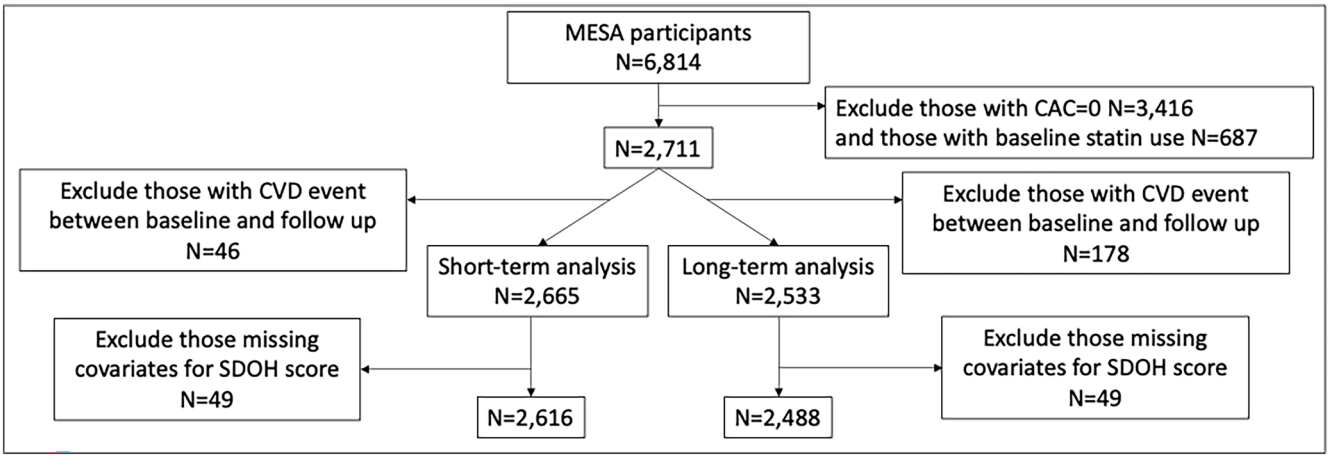


Fig. 2. Flow diagram of participant exclusion criteria.

Table 1
Baseline characteristics by baseline CAC score.

	Overall ($n = 6814$)	CAC=0 ($n = 3416$)	CAC 1–99 ($n = 1794$)	CAC 100–300 ($n = 757$)	CAC >300 ($n = 847$)	p
Age, years	62.15 (10.23)	57.97 (9.13)	64.00 (9.69)	67.68 (8.99)	70.15 (8.12)	**<0.001**
Female sex, n(%)	3601 (52.8)	2167 (63.4)	859 (47.9)	309 (40.8)	266 (31.4)	**<0.001**
Race / ethnicity, n(%)						**<0.001**
Black	1892 (27.8)	1072 (31.4)	463 (25.8)	168 (22.2)	189 (22.3)	
Chinese	804 (11.8)	400 (11.7)	236 (13.2)	98 (12.9)	70 (8.3)	
Hispanic	1496 (22.0)	818 (23.9)	393 (21.9)	135 (17.8)	150 (17.7)	
White	2622 (38.5)	1126 (33.0)	702 (39.1)	356 (47.0)	438 (51.7)	
Language						**<0.001**
English	5363 (78.7)	2640 (77.3)	1385 (77.2)	609 (80.4)	729 (86.1)	
Spanish	805 (11.8)	460 (13.5)	217 (12.1)	67 (8.9)	61 (7.2)	
Chinese	646 (9.5)	316 (9.3)	192 (10.7)	81 (10.7)	57 (6.7)	
Hypertension, n(%)	3058 (44.9)	1200 (35.1)	881 (49.1)	428 (56.5)	549 (64.8)	**<0.001**
Diabetes, n(%)	859 (12.7)	318 (9.3)	241 (13.4)	118 (15.6)	182 (21.6)	**<0.001**
Current smoking, n(%)	887 (13.1)	451 (13.3)	237 (13.2)	92 (12.2)	107 (12.7)	0.839
Hypertension medication use, n(%)	2536 (37.2)	984 (28.8)	726 (40.5)	351 (46.4)	475 (56.1)	**<0.001**
Baseline statin use, n(%)	1010 (14.9)	328 (9.6)	321 (17.9)	152 (20.2)	209 (24.7)	**<0.001**
Exam 2 statin use, n(%)	1223 (20.5)	421 (13.9)	362 (23.4)	174 (26.6)	266 (36.0)	**<0.001**
Exam 5 statin use, n(%)	1752 (37.2)	746 (29.1)	510 (41.8)	218 (47.1)	278 (60.3)	**<0.001**
Body mass index, kg/m^2	28.34 (5.48)	28.32 (5.66)	28.35 (5.39)	28.23 (5.36)	28.48 (5.00)	0.829
Systolic blood pressure, mmHg	126.59 (21.48)	122.40 (20.46)	128.54 (21.14)	132.02 (21.73)	134.53 (22.07)	**<0.001**
Total cholesterol, mg/dL	194.16 (35.73)	193.70 (35.00)	195.31 (36.00)	195.17 (37.54)	192.65 (36.41)	0.209
High density lipoprotein cholesterol, mg/dL	50.96 (14.83)	52.50 (15.01)	49.63 (14.29)	49.39 (14.93)	48.97 (14.51)	**<0.001**
Low density lipoprotein cholesterol, mg/dL	117.20 (31.46)	116.02 (30.71)	119.07 (32.34)	119.13 (31.92)	116.27 (31.94)	**0.002**
CAC (Agatston) score, AU	146.07 (417.21)	0.00 (0.00)	32.07 (27.67)	180.94 (58.06)	945.49 (801.56)	**<0.001**
SDOH score	0.27 [0.14, 0.40]	0.28 [0.14, 0.42]	0.27 [0.14, 0.40]	0.27 [0.13, 0.39]	0.24 [0.13, 0.37]	**<0.001**

Values are presented as n (%), mean (SD) or median (IQR). CAC = coronary artery calcium, GED = general educational development, SDOH = social determinants of health.

(8.82 %); English speakers had the greatest prevalence at long-term follow-up (37.26 %), followed by Spanish (34.59 %) and Chinese (24.48 %) speakers ($p < 0.001$). For SDOH score, there was a lower prevalence of short-term follow-up statin use with higher SDOH score tertile (worse burden). At long-term follow-up, there was a lower prevalence of statin use among those in the third SDOH tertile compared with the first (Fig. 3).

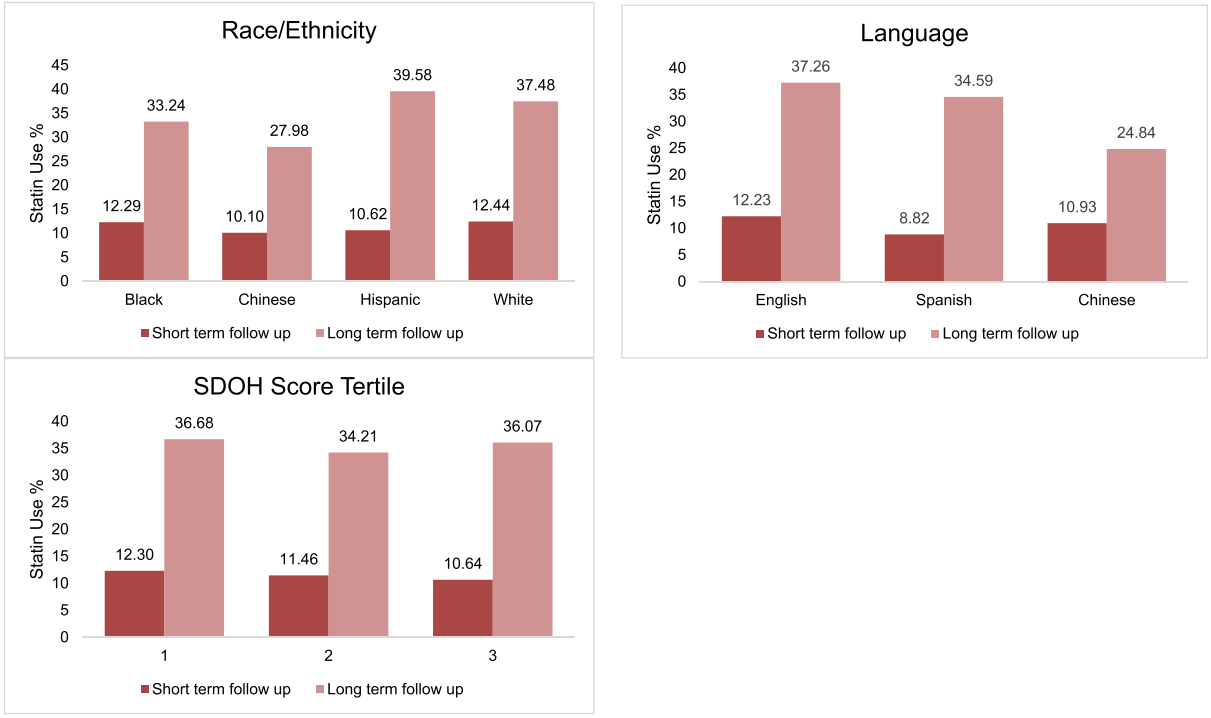


Fig. 3. Prevalence of statin use at follow-up by race/ethnicity, language, and social determinants of health. $p < 0.001$ for race/ethnicity and language at long-term follow-up.

3.2. Social determinants of health and statin use

At short-term follow up (median 1.6, IQR 1.4–1.8 years), higher SDOH score (greater burden) was inversely associated with statin use (OR 0.39, 95 % CI 0.16–0.91) in individuals with CAC >0 in multivariable analyses. At long-term follow up (median 9.4, IQR 9.1–9.7 years), a similar, but non-significant, inverse trend was noted for SDOH score (OR 0.53, 95 % CI 0.26–1.09, Fig. 4).

At short-term follow-up, Hispanic race/ethnicity (OR 0.59, 95 % CI 0.40–0.85) and Spanish speaking (OR 0.51, 95 % CI 0.30–0.83) were inversely associated with statin use. At long-term follow-up, Black race/ethnicity (OR 0.71, 95 % CI 0.52–0.96), Chinese race/ethnicity (OR 0.58, 95 % CI 0.39–0.86) and Chinese speaking (OR 0.50, 95 % CI 0.33–0.76, Fig. 4) were inversely associated with statin use.

Among traditional cardiovascular risk factors, age, total cholesterol, diabetes and hypertension medication were positively associated with statin use at short-term follow-up, while HDL-C was inversely associated. At long-term follow-up, total cholesterol, diabetes and

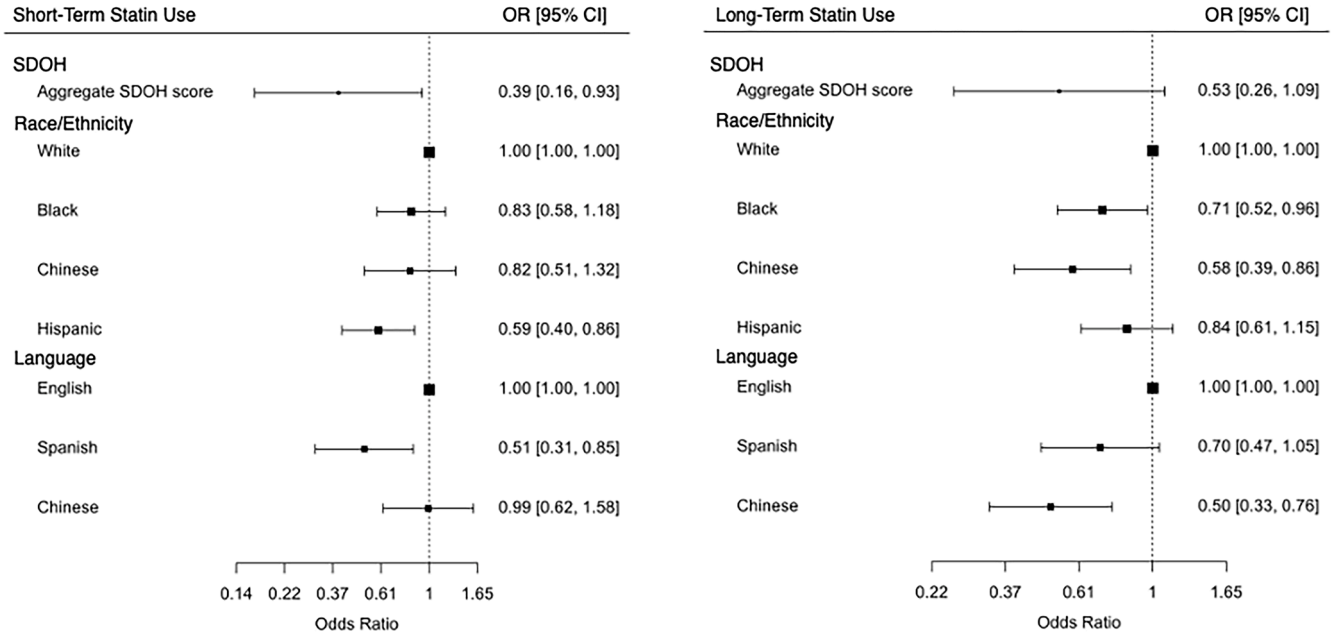


Fig. 4. Social determinants of health and statin use at follow-up exams. Adjusted for traditional risk factors (age, sex, BMI, SBP, total cholesterol, HDL-C, diabetes mellitus, smoking status, use of anti-hypertensive medications). Abbreviations per Table 1.

hypertension medication were positively associated with statin use. There was an inverse association between female sex and short- and long-term statin use, but this was not statistically significant (**Supplemental Table 1**). When stratified by CAC score, results were generally consistent among those with CAC ≥100 and CAC ≥300 AU (**Supplemental Table 2**).

4. Discussion

Our findings highlight several disparities in statin use after identification of CAC based on race/ethnicity, language, and SDOH burden. We found that at short-term follow up, Hispanic/Latino and Spanish speaking individuals were less likely to report statin use following CAC identification. At long-term follow up, Black individuals, Chinese individuals, and Chinese speaking individuals were also less likely to report statin use following CAC identification. An inverse relationship was observed between female sex and short and long-term statin use however this was not statistically significant. We found that at short-term follow up, those with a higher SDOH score (worse burden), were less likely to report statin use, and a trend was similarly noted at long-term follow up.

Disparities in cardiovascular care by race/ethnicity are well established [21]. Among hospitalized patients with non-ST-Segment Myocardial Infarction (NSTEMI), Black patients have been less likely to receive guideline-based NSTEMI therapies [22]. In addition, one study demonstrated lower rates of aspirin and guideline-directed medical therapy (GDMT) in Black patients with coronary artery disease [23]. Furthermore, one study demonstrated that Black patients and patients experiencing homelessness were less likely to have GDMT optimized during hospitalization for heart failure with reduced ejection fraction [24]. Specifically with regards to statins, studies have identified a lower prevalence of statin use for primary prevention among non-Hispanic Black men and non-Mexican Hispanic women, which were not explained by measurable differences in medical appropriateness of therapy, access to healthcare, and socioeconomic status [3]. One study also found Black individuals were less likely to receive guideline-recommended statin therapy [25].

Previous studies have also identified SDOH such as access to care and routine place of care as predictors for statin use [26]. Similarly, a previous study has demonstrated that among those with indications for statin use based on ATP III guidelines, only 45 % of those with >4 vulnerabilities (older age, Black race female sex, high area-level poverty, lack of health insurance) were receiving statins compared to 65 % of those without [27]. Sex differences in statin use have also been described, demonstrating that women are less likely to be treated with statins than men [5,28]. Our study adds to these findings, highlighting racial/ethnic disparities and disparities by SDOH in statin use, despite identification of CAC. We also observed an inverse relationship between female sex and statin use, though results were not statistically significant. These findings highlight an important area for future study, particularly as ASCVD disproportionally affects racial and ethnic minority populations.

Our study has important clinical implications. The association between CAC and coronary artery disease has been well established, and it has become a useful tool to identify subclinical atherosclerosis and support shared decision making with regards to initiating statin therapy. Our study identifies racial/ethnic and socioeconomic disparities in statin use both at short- and long-term follow-up after identification of CAC. Prior studies have also demonstrated disparities in obtaining CAC scoring. One study demonstrated that CAC scanning is disproportionately utilized by self-paying White patients [29]. Likewise, another study highlighted that individuals from lower income areas are less likely to obtain CAC scoring [15]. While these studies highlight the need to improve utilization of CAC testing amongst underrepresented groups, our study highlights an additional need to ensure equitable use of appropriate preventive therapies after identification of CAC. Because CAC scoring provides an objective measurement of coronary artery disease beyond traditional risk factors, this may serve as a useful tool to standardize risk assessment across different socioeconomic backgrounds, ensuring individuals with similar risk profiles receive appropriate statin therapy. Our findings add to the growing body of research identifying disparities in cardiovascular care, and underscore the need for targeted multi-disciplinary interventions to address SDOH burden, which could include culturally competent health care approaches, improved patient education about CAC and prevention, and enhanced health care systems to mitigate the impact of SDOH on cardiovascular treatment. Our study benefits from a large, diverse population and all patients in MESA underwent baseline CAC scoring, allowing us to prospectively evaluate differences in management after identification of CAC over long-term follow-up.

Our study has several notable limitations. Statin use and components of the aggregate SDOH score were based on self-report, which is subject to recall bias. Furthermore, although the 2019 ACC/AHA Guidelines on the Primary Prevention of Cardiovascular Disease recommend statin therapy for intermediate-risk individuals with any CAC, with a stronger consensus among global guidelines for statin use among those with CAC ≥100 AU [12], the MESA study was conducted prior to these recommendations. The analysis restricted to individuals with CAC≥100 was limited in sample size and statistical power, though the point estimates for predictors of statin prescription were generally similar to those with CAC>0. Furthermore, the presence of even low levels of CAC has been associated with increased risk for cardiovascular events [30].While we accounted for available socioeconomic factors and clinical indications for statin use, there may be unmeasured confounding variables such as cultural beliefs [25], patient preferences, patient-clinician communication, cultural competence, and health literacy that may influence statin use. Additionally, statin use at follow-up after identification of CAC may not completely reflect statin prescription as other factors may influence an individual's decision to take a statin even if they were prescribed one. The overall use of statins was low, even among individuals with CAC, and this may have limited statistical power to detect disparities among specific subgroups. Studies with larger sample sizes should be pursued to evaluate individual disparities further. Finally, it is worth noting that these results are subject to selection bias, and may represent a best-case scenario, as participants in the MESA cohort underwent a thorough evaluation at baseline and several subsequent visits, including receipt of results and instructions to discuss them with their clinician. This systematic follow up may not be representative of the general population where access and follow-up care vary.

5. Conclusions

In this prospective cohort study we identified racial/ethnic, language and socioeconomic disparities in statin use after identification of CAC during a baseline visit between 2000–2002. Future studies should investigate underlying reasons for these disparities and potential interventions to reduce disparities in cardiovascular care.

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CRediT authorship contribution statement

Charlotte C. Ellberg: Writing – review & editing, Writing – original draft, Visualization, Methodology, Conceptualization. **Kavenpreet Bal:** Writing – review & editing. **Edward Duran:** Writing – review & editing. **Michael H. Criqui:** Writing – review & editing. **Michael D. Shapiro:** Writing – review & editing. **Harpreet S. Bhatia:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Harpreet S. Bhatia reports financial support was provided by National Institutes of Health. H.S.B - consultant / advisor for Kaneka, Novartis, Abbott, Arrowhead; editorial board for AJPC M.D.S - supported by institutional grants from Amgen, Arrowhead, Boehringer Ingelheim, 89Bio, Esperion, Novartis, Ionis, Merck, and New Amsterdam. He has participated in Scientific Advisory Boards with Amgen, Agepha, Ionis, Novartis, New Amsterdam, and Merck. He has served as a consultant for Ionis, Novartis, Regeneron, Aidoc, Shanghai Pharma Biotherapeutics, Kaneka, Novo Nordisk, Arrowhead, and Tourmaline. If there are other authors, they 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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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajpc.2025.100990.

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