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## Research Brief

## Cardiovascular health and subclinical atherosclerosis in second generation South Asian Americans: The MASALA study

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## ABSTRACT

We describe cardiovascular health (CVH) in second-generation (U.S.-born) South Asian Americans in the MASALA study, a population for whom CVH is not previously described. CVH factors in second-generation (N = 21) compared with first-generation (N = 495) South Asian Americans included: total cholesterol (199 ± 31 versus 191 ± 35 mg/dL, p = 0.25), low-density lipoprotein cholesterol (121 ± 27 versus 115 ± 30 mg/dL, p = 0.41), triglycerides (163 ± 197 versus 138 ± 72 mg/dL, p = 0.10), diet score (66 ± 8 versus 70 ± 6 points, p = 0.06), BMI (27.6 ± 4.9 versus 26.2 ± 4.1 kg/m<sup>2</sup>, p = 0.12), and CAC prevalence (26.3% versus 23.9%, p = 0.34). Age- and sex-adjusted differences were not statistically significant. Further investigation of CVH in this risk-enhanced population may help identify differences between second-generation and first-generation immigrant South Asians in the U.S.

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## 1. Introduction

South Asians have disproportionately higher burden of atherosclerotic cardiovascular disease (ASCVD) compared with other Asian and non-Asian populations in the United States (US), with up to 43% higher proportional mortality from ischemic heart disease in Asian Indian men compared with non-Hispanic white men.<sup>1,2</sup> Consequently, the American Heart Association identifies South Asian ethnicity as an ACSVD “risk-enhancing” factor.<sup>3</sup> Gaps remain in understanding cardiovascular health (CVH) and subclinical ASCVD, particularly in the growing population of second-generation South Asian American children of immigrants.<sup>4</sup> South Asian Americans had relatively poor CVH in a community sample,<sup>5</sup> but second-generation South Asian Americans may have different CVH profiles compared with first-generation immigrant South Asians in the US. Evidence from other US immigrant populations shows that multi-level factors like environment and diet differ by

generation, which may contribute to worse CVH in second-generation populations.<sup>6,7</sup> To inform further study of this risk-enhanced population, we identified prevalence estimates of CVH factors and subclinical atherosclerosis in second-generation South Asian Americans in the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study.

## 2. Methods

## 2.1. Study sample

CVH and subclinical atherosclerosis data were collected in a community sample of South Asian Americans without ASCVD enrolled in the MASALA study. We evaluated second-generation (G2, i.e., born in the US) participants and first-generation (G1, i.e., born outside the US) South Asians of the same age range of the second-generation group (40–54 years), thus participants age ≥55 were excluded. In secondary analysis, a “Generation 1.5” (G1.5) subset was identified within G1 as those who immigrated at age ≤15 years, representing a group with bridged language, cultural, and behavioral characteristics generally defined as those who arrived in their mid-teens.<sup>8</sup> In a secondary sensitivity analysis G1

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participants were restricted to only those born in India. The MASALA study was approved by the Institutional Review Boards at Northwestern University and University of California, San Francisco. Participants provided written informed consent.

2.2. Measures

MASALA study data collection methods have previously been detailed.<sup>9</sup> We evaluated participant age; sex; systolic and diastolic blood pressure; total, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) cholesterol and triglycerides; fasting glucose and hemoglobin A1c; body-mass index (BMI); self-reported exercise (MET-min/week); diet score (alternate healthy eating index, AHEI); smoking status (current, former, or never); use of statin medications; estimated 10-year ASCVD risk (in non-statin users); common and internal carotid intima-media thickness; and coronary artery calcium (CAC) score in the G1, G1.5 subset, and G2 participants. A summary CVH score based on the AHA's Life's Simple 7 construct was calculated (range 0–14, with 14 representing ideal CVH).<sup>5</sup>

2.3. Statistical analysis

Frequency, mean (standard deviation, SD) or median (25th to 75th percentile) of CVH and subclinical atherosclerosis measures were calculated. Independent samples *t*-tests were used to calculate mean and proportion differences and standard errors (SE). Differences in continuous and categorical measures in G2 versus G1, and secondarily in G1.5 versus Late-G1 (immigrants who arrived age >15 years, and G1.5 versus G2 participants, were evaluated with unadjusted and age- and sex-adjusted linear and logistic regression. Analyses were conducted using SAS v9.4.

3. Results

The distributions of CVH factors and subclinical atherosclerosis measures in G2 and G1 South Asian participants are shown in

**Table 1.** There were 21 G2 participants and 495 G1 participants (86% born in India). Mean (SD) age was 45.5 (4.5) years in G2 and 48.2 (4.1) years in G1. G2 and G1 participants were 48% and 51% women, respectively. G1 participants had lived an average of 22.1 (8.4) years in the US.

Age- and sex-adjusted differences in CVH and subclinical atherosclerosis measures were not statistically significant. CVH factors in G2 compared with G1 South Asians were: total cholesterol (199 [31] versus 191 [35] mg/dL, respectively, *p* = 0.25), LDL cholesterol (121 [27] versus 115 [30] mg/dL, *p* = 0.41), triglycerides (163 [197] versus 137 [72] mg/dL, *p* = 0.10), self-reported exercise (982 [367–1480] versus 945 [315–1890] MET-min/week, *p* = 0.64), diet score (66 [8] versus 70 [7] points, *p* = 0.06), smoking (19% versus 15% current/former, *p* = 0.64), and BMI (27.6 [5] versus 26.2 [4.1] kg/m<sup>2</sup>, *p* = 0.12). Approximately 26% of G2 participants had non-zero CAC, compared with 24% of G1 participants (*p* = 0.34). Sensitivity analysis limiting G1 participants to only those born in India yielded similar results.

**Table 2** shows CVH and subclinical atherosclerosis in the subset of G1.5 participants (mean age 46.4 [3.6] years, 37% women, mean time in the US 38 [5] years), compared statistically to the Late-G1 and G2 participants. Total cholesterol was significantly higher in G1.5 compared with Late-G1 participants (204 [37] vs. 190 [35] mg/dL, *P* = 0.01). In G1.5 participants, 5.3% were current/former smokers, compared with 15.5% in Late-G1, *P* = 0.04. No other age- and sex-adjusted statistically significant differences between G1.5 and Late-G1 or G2 participants were observed.

4. Discussion

Our findings provide novel initial prevalence estimates and distributions of CVH and subclinical atherosclerosis in G2 and G1.5 South Asian Americans. These observations emphasize the need for further study of differences in modifiable CVH factors in second compared with first-generation South Asian Americans, and early versus late-arriving first generation South Asians. Studies of other immigrant populations have revealed considerable differences in

**Table 1**  
Cardiovascular health and subclinical atherosclerosis in South Asian Americans by generation.

	G1	G2	P	Difference G2 vs. G1*
N	495	21		
Age, mean (SD)	48.2 (4.1)	45.5 (4.5)		
Women, N (%)	253 (51.1)	10 (47.6)		
Years in the United States, mean (SD)	22.1 (8.4)	–		
Systolic blood pressure, mmHg, mean (SD)	121 (13)	120 (15)	0.67	–1 (3)
Diastolic blood pressure, mmHg, mean (SD)	75 (10)	75 (12)	0.70	0 (2)
Total cholesterol, mg/dL, mean (SD)	191 (35)	199 (31)	0.25	8 (8)
LDL cholesterol, mg/dL, mean (SD)	115 (30)	121 (27)	0.41	6 (7)
HDL cholesterol, mg/dL, mean (SD)	49 (13)	52 (15)	0.15	3 (3)
Triglycerides, mg/dL, mean (SD)	137 (72)	163 (197)	0.10	26 (18)
Fasting glucose, mg/dL, mean (SD)	98 (25)	97 (14)	0.84	–1 (5)
Hemoglobin A1c, %, mean (SD)	5.9 (0.8)	5.8 (0.4)	0.64	–0.1 (0.2)
Exercise, MET-min/week, median (IQR)	945 (315–1890)	982 (367–1480)	0.64	37 (–)
Diet score, mean (SD)	69.7 (6.6)	66.4 (7.5)	0.06	–3.4 (1.6)
Smoking (current/former), N (%)	73 (14.7)	4 (19.0)	0.64	4.3% (8.0)
BMI, kg/m <sup>2</sup> , mean (SD)	26.2 (4.1)	27.6 (4.9)	0.12	1.5 (0.9)
CVH score, mean (SD)	9.3 (2.0)	8.8 (2.4)	0.08	–0.5 (0.5)
Statin use, N (%)	90 (18.2)	3 (14.3)	0.66	–3.9% (8.6)
10-year ASCVD risk (in non-statin users), percent, mean (SD)	2.6 (2.8)	1.8 (1.7)	0.65	–0.8 (2.8)
Common CIMT, mm, mean (SD)	0.80 (0.17)	0.78 (0.12)	0.73	–0.02 (0.04)
Internal CIMT, mm, mean (SD)	1.06 (0.29)	0.94 (0.35)	0.25	–0.12 (0.07)
Any coronary artery calcium, N (%)	104 (23.9)	5 (26.3)	0.34	2.4% (10.0)

G1: first-generation, i.e. South Asian Americans born outside of the US, G2 = second-generation, i.e. South Asian Americans born in the US, CIMT: carotid intima-media thickness, IQR: interquartile range (25th to 75th percentile). \*Mean difference (standard error of mean difference), median difference, or proportion difference (standard error of proportion difference) of G2 compared to G1.

**Table 2**  
Cardiovascular health and subclinical atherosclerosis in South Asian Americans by generation.

	Late-G1	G1.5	P G1.5 vs. Late- G1	Difference G1 vs. Late- G1*	G2	P G2 vs. G1.5	Difference G2 vs. G1.5*
N	457	38			21		
Age, mean (SD)	48.4 (4.1)	46.4 (3.6)			45.5 (4.5)		
Women, N (%)	239 (52.3)	14 (36.8)			10 (47.6)		
Years in the United States, mean (SD)	20.8 (7.2)	38.2 (4.8)			—		
Systolic blood pressure, mmHg, mean (SD)	121 (13)	120 (17)	0.70	−1 (2)	120 (15)	0.94	0 (5)
Diastolic blood pressure, mmHg, mean (SD)	75 (10)	74 (9)	0.32	−1 (2)	75 (12)	0.54	1 (3)
Total cholesterol, mg/dL, mean (SD)	190 (35)	204 (37)	0.01	14 (6)	199 (31)	0.52	−5 (9)
LDL cholesterol, mg/dL, mean (SD)	115 (30)	121 (30)	0.22	6 (5)	121 (27)	0.97	0 (8)
HDL cholesterol, mg/dL, mean (SD)	49 (13)	51 (18)	0.03	2 (2)	52 (15)	0.89	1 (5)
Triglycerides, mg/dL, mean (SD)	135 (70)	154 (89)	0.17	19 (12)	163 (197)	0.67	9 (37)
Fasting glucose, mg/dL, mean (SD)	99 (25)	92 (14)	0.10	−7 (4)	97 (14)	0.14	5 (4)
Hemoglobin A1c, %, mean (SD)	5.9 (0.8)	5.7 (0.7)	0.10	−0.2 (0.1)	5.8 (0.4)	0.55	0.1 (0.2)
Exercise, MET-min/week, median (IQR)	870 (315 −1838)	1601 (742 −2422)	0.12	731 (−)	982 (367 −1480)	0.82	−619 (−)
Diet score, mean (SD)	69.7 (6.5)	70.0 (7.8)	0.37	0.3 (1.2)	66.4 (7.5)	0.09	−3.6 (2.2)
Smoking (current/former), N (%)	71 (15.5)	2 (5.3)	0.04	−10.3% (6.0)	4 (19.0)	0.14	13.7% (8.2)
BMI, kg/m <sup>2</sup> , mean (SD)	26.1 (4.0)	27.0 (5.3)	0.18	0.9 (0.7)	27.6 (4.9)	0.63	0.6 (1.4)
CVH score, mean (SD)	9.2 (2.0)	9.5 (2.2)	0.68	0.3 (0.4)	8.8 (2.4)	0.17	−0.7 (0.6)
Statin use, N (%)	86 (18.8)	4 (10.5)	0.14	−8.3% (6.5)	3 (14.3)	0.57	3.8% (14.1)
10-year ASCVD risk (in non-statin users), percent, mean (SD)	2.6 (2.9)	2.4 (2.1)	0.60	−0.2 (5.3)	1.7 (1.7)	0.64	−0.7 (5.9)
Common CIMT, mm, mean (SD)	0.80 (0.17)	0.78 (0.18)	0.57	−0.02 (0.03)	0.78 (0.12)	0.28	0 (0.05)
Internal CIMT, mm, mean (SD)	1.05 (0.28)	1.09 (0.37)	0.40	0.04 (0.05)	0.94 (0.35)	0.36	−0.15 (0.10)
Any coronary artery calcium, N (%)	92 (23.1)	12 (33.3)	0.24	10.3% (7.4)	5 (26.3)	0.90	−7.0% (13.3)

Late-G1: late arrival first-generation, i.e. South Asian Americans born outside of the US and arrived >15 years of age, G1.5: intermediate generation, i.e. South Asian Americans born outside of the US and arrived ≤15 years of age, 2G = second-generation, i.e. South Asian Americans born in the US, CIMT: carotid intima-media thickness, IQR: interquartile range (25th to 75th percentile). \*Mean difference (standard error of mean difference), median difference, or proportion difference (standard error of proportion difference).

health status between heterogeneous immigrant populations with variability by generation and ethnicity,<sup>6,10,11</sup> which are likely influenced by intergenerational multi-level environmental, socio-economic, sociocultural, interpersonal, and individual factors. Further dedicated study of second-generation South Asian Americans is necessary to comprehensively characterize CVH and subclinical atherosclerosis in the risk-enhanced South Asian American population across generations, and also to understand the multi-level factors that may contribute to differences in CVH between immigrant and subsequent generation South Asians. This analysis is limited by the small sample of G2 and G1.5 South Asians, likely due to the initial age eligibility of MASALA since subsequent generation South Asians are younger. The limited sample size also precludes further evaluation of differences between South Asian subgroups, such as in Pakistani or Bangladeshi Americans. These findings underscore the need to study potential CVH differences in larger samples of second-generation South Asian Americans.

**Disclosures and competing interests**

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