Acculturation, Coronary Artery Disease and Carotid Intima Media Thickness in South Asian Immigrants - Unique Population with Increased Risk

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Context: South Asian Immigrants (SAIs) are the 2nd fastest growing Asian immigrant population in the United States with high rates of coronary artery disease (CAD) and type 2 diabetes (T2D). There is a need to identify markers that can help in identifying high risk groups at an early stage so CAD can be prevented.

Objective: To measure the level of acculturation and its association with CAD, sub-clinical CAD, CAD risk factors and T2D in SAIs in the United States.

Design: Using an epidemiologic cross-sectional study design, 159 SAIs aged 35–65 years were recruited. Subclinical CAD was assessed using common carotid artery intima media thickness (CCA-IMT) as a surrogate marker for atherosclerosis. Scaled (The Suinn-Lew Asian Self-Identity Acculturation scale [SL-ASIA Scale]) and non-scaled (≥10 years stay in the United States) methods were used to measure the acculturation.

Results: 67.7% of SAIs were identified to have high acculturation based on SL-ASIA scale. On the logistic regression age-adjusted model, ≥10 years stay in the US (P=.006), cholesterol level ≥200 mg/dL (P<.001), BMI≥23 (P=.004), and family history of CAD (.007) were found to be significantly associated with CAD. T2D was associated with high acculturation (P<.001) and CCA-IMT (P=.01) beside other CAD risk factors.

Conclusions: Acculturation may play a major role in predisposing immigrant populations to CAD, however insufficient research has been done in this field. Further studies are needed to provide large scale information on acculturations and its association with CAD. (*Ethn Dis.* 2011;21(3):314–321)

Key Words: South Asian Immigrants, Acculturation, Coronary Artery Disease, Type 2 Diabetes

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Introduction

Population

The cultural composition of the United States is diverse and rapidly changing due to a rising immigrant population. South Asians (SAs) are the fastest growing (with growth rate of more than 140%) and second largest Asian immigrant group in the United States.[1] Asian Indians, together with people who identify with the cultures of Bangladesh, Sri Lanka, Nepal and Pakistan, are grouped as South Asians and account for more than 3.5 million US residents. An additional 1.3 million SAs with illegal status, mainly from India, make India the fourth-largest ranking source country for undocumented US immigrants.[2] The first wave of South Asian Immigrants (SAIs) in the US consisted mainly of men in the mid 19th century.[3] For a while afterwards, discriminatory legislation halted Asian immigration to the United States. It was not until the passage of the Immigration and Naturalization Act of 1965 that immigration restrictions were lifted and SAIs were allowed again to come to the United States; The second and third waves of SAI immigration came from South Asian countries and other diaspora sites worldwide.[1] Unlike the first wave of SAIs, there was a wide range of educational and economic backgrounds within the newer immigrants. Intending to establish life in the US, the second and third wave SAIs accepted the challenge of negotiating an unfamiliar cultural, social, economical, and political context and adapting their traditional beliefs, values, and practices toward a productive US life.[3] The SAI community is very diverse with more than 16 languages and six religions.[2] However, despite their differences, they share a common cultural history and immigration patterns.

Disease Risk

Aggressive clinical and public health interventions have resulted in a significant reduction in cardiovascular diseases (CVDs) mortality. However, CVD in general and coronary artery disease (CAD) in particular are still the leading causes of mortality and morbidity in the United State, accounting for more than 40% of all deaths.[4–7] Moreover, there is troubling evidence that the prevalence of CAD and its risk factors are on the rise in immigrants who constitute more than 11% of the US population. Several studies during the past decade have confirmed that CAD-related morbidity and mortality are consistently and significantly higher among SAIs than other immigrant populations in England, Malaysia, Uganda, West Indies, Trinidad, South Africa and the United States.[8–10]

India leads the world with the greatest number of patients with type 2 diabetes (T2D), earning the dubious distinction of being termed the diabetes capital of the world. According to the Diabetes Atlas 2006 published by the International Diabetes Federation (IDF), the number of people with diabetes in India is currently around 40.9 million. This susceptibility of diabetes among South Asians in general and SAIs in particular promotes an adverse CAD risk, even in patients treated for high blood pressure and cardiovascular risk. Insulin resistance is postulated as a central feature of the metabolic syndrome, culminating in diabetes, atherosclerotic vascular disease and CAD; a pathway potentially accelerated by migration/urbanization.[10–12]

Differences in CVD-related mortality between SAIs and South Asians in their native countries could be due to: (a) the new environment triggering latent genetic susceptibilities, or (b) effects of immigration on environmental and behavioral changes that increase the incidence of these diseases and their risk factors.[13–15] Susceptibility to these effects in SAIs may not be uniform. Immigrants frequently experience stress as they adapt to a new environment and acculturation varies with education, language proficiency, length of stay (immigration status), and family structure.[12–17]

Although clinical guidelines for CAD prevention recommend risk management based on Framingham Risk Scores (FRS),[18–19] CAD event rates corresponding to FHS scores are not known for SAIs and FRS may underestimate risk.[18] Intermediate CAD outcomes such as increased common carotid artery intima media thickness (CCA-IMT) can also be a useful marker to stratify high risk SAIs without CAD. We have shown in previous studies the high prevalence of CCA-IMT (42%) in SAIs is much higher than other populations, and age-adjusted mean CCA-IMT is higher in SAIs who had at least one parent with CAD.[20–21]

Furthermore, studies among Asian and Hispanic immigrants in the Southeastern United States indicate that those with longer residence and more acculturation have greater CAD risk.[16–17] Acculturation can influence metabolic syndrome and CAD risk through its effect on several CAD risk factors and CAD intermediate outcomes such as CCA-IMT. No study, however, has examined these relationships in SAIs. Because there is insufficient data about acculturation and CAD, the current study was conducted to measure the level of acculturation and its association with CAD and other factors, including T2D and CCA-IMT in SAIs in the Midwestern and Southern regions of the United States, one of the SAIs high-concentration areas. Results obtained from this study will help develop prospective studies assessing the long-term role of acculturation in increasing CAD risk, and help in developing specific tools for predicting CAD in ethnic minorities like SAIs.

STUDY METHODS AND DESIGN

Using an epidemiologic cross-sectional study design, SAIs aged 35–65 years and without known CAD (on medical history) were recruited from the main Hindu temples and other Hindu population concentrated areas in the states of Georgia, Kansas and Missouri. We chose this age group because CAD and its risk factors occur at younger ages in SAIs as compared to other populations.[10] The SAI population in Georgia, Kansas and Missouri is most readily accessed through their temples of worship. Study information was made available by distributing flyers in the temples and making announcements on weekends and through local newspapers outlining the purpose, rationale, and design of the study. After written informed consent was obtained, information on sociodemographic status, ethnicity (based on spoken language), personal lifestyle characteristics, and both traditional and non-traditional risk factors for CAD was obtained (Table 1).[13] Risk factors were defined using standard definitions.[22–26] Type 2 diabetes was diagnosed on history (known diabetic and/or on medication) and/or 12-hr fasting blood sugar level.[24] Acculturation was measured using both scaled (Suinn-Lew Asian Self-Identity Acculturation scale [SL-ASIA Scale])[27–28] and non-scaled measures (total number of years living in the United States). Twelve-hour fasting blood samples were collected for measurements of high sensitivity C-reactive protein (hsCRP), total cholesterol, triglycerides (TGs), high density lipoprotein (HDL), low density lipoprotein (LDL), lipoprotein a (Lp[a]) and insulin levels. Due to limited funds, blood testing was done in only 50 participants (Table 1). Subclinical CAD was assessed by common carotid artery ultrasound, using intima-media thickness (CCA-IMT) as the surrogate marker for atherosclerosis. CCA-IMT measurements were obtained on only 35 participants.

Results obtained from this study will help develop prospective studies assessing the long-term role of acculturation in increasing CAD risk.

Carotid Ultrasound Doppler

B-mode ultrasound scanning of bilateral carotid arteries was performed by a trained non-invasive vascular ultrasound technician using SonoCalc™ Micromax IMT machine (SonoSite, Inc Bothell, WA) with a 10.0 MHz linear array transducer. Details are reported previously.[29] Briefly, both CCAs were scanned with the participant in the supine position. A total of four images were obtained on each side, 1 cm proximal to the carotid bulb using an anterior approach. Images were obtained at an angle to show good lumen-intima and media-adventitia demarcation and were recorded and stored on a disk for off-line analysis. The ECG leads were placed to obtain end-diastolic measurements. The CCA approach for IMT measurements was preferred because of reproducibility of results and predictability for future CV events.[30] Any focal thickening of the intima-media complex or carotid plaque was recorded but not included in the analysis. Two cardiologists who were blinded with respect to the patient's

Table 1. Sociodemographic and cardiovascular characteristics (*N*=159)

Variable	*n* (%)
Sex	
Male	87 (54.0)
Female	74 (46.0)
Age	53.1±10.3*
<40 years	21 (13.0)
≥40 years	140 (87.0)
Acculturation†	
Low, score 1 to 2	42 (26.1)
High, biculturation and westernization, score 2.1 to 5	109 (67.7)
Hypertension‡	34 (21.1)
Cholesterol ≥ 200mg/dL‖	78 (48.4)
History of T2D	36 (22.6)
History of CAD§	15 (9.4)
Smoking	6 (3.8)
Family history of CAD	59 (37.6)
Family history of T2D	77 (49.0)
Body Mass Index[17]¶	25.69±3.39*
Normal, BMI<23	16 (21.3)
Overweight, BMI 24–29	9 (12.0)
Obese, BMI 30–39	41(54.7)
Morbidly obese BMI≥40	9 (12.0)
Waist circumference#	
Males	91.35±7.65*
Females	87.09±11.74*
≥ 90 cm in men	18 (11.2)
≥ 80 cm in women	17 (10.6)
Physical activity	81 (67.5)
Impaired fasting glucose levels, 100–125mg/dL**	13 (33.3)
Insulin levels ≥20 ul/mL**	2 (5.7)
HDL levels‖ ≤40 mg/dL**	48.86±10.4* 12 (34.3)
LDL levels ≥150 mg/dL††**	122.03±40.98* 12 (35.3)
Triglycerides ≥150 mg/dL**	150.74±87.33* 13 (37.1)
HsCRP ≥8mg/L‡‡**	8.94±22.5* 2 (5.7)
Apo A1 ≥200 mg/dL‡‡**	176.57±19.43* 3 (8.6)
Lp[a] ≥30 mg/dL**	26.80±27.90* 10 (28.6)
Fibrinogen activity <175 and >425 mg/dL	4 (21.1)
CCA-IMT measure ≥0.8**	16 (45.7)

* Mean ±standard deviation.
† Based on Suinn-Lew Asian Self-Identity Acculturation scale (SL-ASIA Scale) *n*=151.[27–28]
‡ Defined by Joint National committee VII (JNC VII) criteria.[25]
§ Based on International Diabetes Federation criteria.[24]
‖ Based on National Cholesterol Education program ATP III criteria (NCEP-ATP III).[26]
¶ *n*=75.
# *n*=61.
** *n*=35.
†† In non-CAD subjects.
‡‡ In CAD subjects; hsCRP, high sensitivity C-reactive protein; Apo A-I, Apo lipoprotein A-I; T2D, type 2 diabetes; CAD, coronary artery disease; BMI, body mass index.

medical history reported CCA-IMT findings using automated edge detection technology software (SonoCalc™ IMT). Measurements of the far wall of the CCA were done as they are more indicative of the true thickness of the arterial wall. A CCA-IMT cut-off of ≥.80 mm was chosen and analyzed as positive IMT measurements based on the available evidence supporting the presence of sub-clinical CAD.[31] Therefore, participants with values of .80 mm or greater were considered abnormal and were reported as IMT-positive.

Acculturation

Acculturation was measured using both scaled, the SL-ASIA Scale[27–28] as well as non-scaled (eg, number of years in the US) methods. The SL-ASIA Scale is a 21-item multiple-choice questionnaire covering language (4 items), identity (4 items), friendship (4 items), behaviors (5 items), generation/ geographic history/enclave residence (3 items), and attitudes (1 item). A validated Indian-Gujarati language version of this scale was used for non-English-speaking participants. In scoring the scale, a total value was obtained by summing the answers for all 21 items. A final acculturation score was calculated by dividing the total value by 21; a score ranged from 1.00–2.00 (low acculturation, reflecting high Asian identification), 2.1–3.00 (biculturation) and >3.00 (high acculturation, reflecting high Western acculturation).[27–28] While the total score reflected the overall level of acculturation, the scale could also be evaluated by component topics such as language, identity, friendships, behaviors, geographic history, and attitudes.

Reliability studies show that Cronbach's alpha for the SL-ASIA Scale for Asian Americans were .91 and .88, reflecting high reliability.[28] A validity study showed that the SL-ASIA scores were significantly correlated with demographic information hypothesized to reflect levels of Asian American identity.[28] For example, high SL-ASIA scores were associated with having attended school in the United States over a longer period of time, during which time the SL-ASIA's Asian identity score would have been reduced.

Statistical Analysis and Power Calculation

The sample size for this small pilot was determined by a 2-sided test at α of .05, with a power (1-β) of 80% to yield a sample size of 150 subjects. This

Table 2. Association of CAD(with and without age adjustment) with acculturation and other risk factors (outcome variable= CAD)

Variable	Without Age Adjustment		With Age Adjustment	
	Wald Chi-square	*P*	Wald Chi-square	*P*
Acculturation, mostly western vs mostly Asian	1.3899	.238	2.3189	.127
Length of stay in United States, ≥10 years	3.5176	.060	7.3136	.006
Cholesterol, ≥200mg/dL vs.<200 mg/dL	6.9463	.008	13.6570	<.001
T2D	1.8151	.177	3.4205	.064
Hypertension, ≥120 SBP or ≥90 DBP	.4881	.484	16.2329	.364
Family history of T2D	.0881	.766	0.0925	.761
Family history of CAD	3.4159	.064	7.0853	.007
Waist circumference, male ≥90 cm; female≥80cm	.3136	.575	.6270	.428
BMI, ≥23.1 vs ≤23	3.9594	.046	8.0956	.004
Physical activity	.3507	.553	.9093	.340

T2D, type 2 diabetes; CAD, coronary artery disease; BMI, body mass index.

sample size provided sufficient power to hypothesize higher (>50%) prevalence of high acculturation (primary outcome) and its association with CAD, subclinical CAD and CAD risk factors, including T2D. We inflated the study sample to 170 to account for any dropouts or incomplete data. Body mass index (BMI) was calculated by using Quatelet's index (weight in kilograms/height in meters squared). A BMI of ≥23 was considered overweight and ≥30 as obese according to the recent WHO guidelines.[32] Logistic regression was performed with CAD and T2D as outcome variables and to understand acculturation with CCA-IMT and CAD risk factors. The Fisher's exact test was used to assess the relationship between the variables. Significance of $P \leq .05$ was used for all tests. Multiple logistic regression model was used for testing associations. Statistical analysis was performed using the StatView statistical package (2006, SAS Institute, Cary, North Carolina).

RESULTS

Out of 173, complete information was obtained on 159 (92%) participants and thus constituted our study sample; participants' characteristics are shown in Table 1. The mean age was 53.1 ± 10.3 with 54% males. The SAIs, in general, share a very heavy burden of CAD risk factors; prevalence of hypertension (21.1%), high cholesterol ≥200 mg/dL (48.4%), obesity BMI≥30 (66.7%), and family history of CAD (37.6%). History of CAD and T2D was 9.4% and 22.6%, respectively (Table 1) while prevalence of CCA-IMT was 45.7%.

21.8% of participants had waist circumference ≥90 cms in males and ≥80 cms in females. Similarly 78.7% had BMI ≥ 23, and of those 12.0% were overweight, 54.7% were obese and 12.0% were morbidly obese. It is noteworthy that around 33.3% of participants had impaired glucose tolerance; low HDL (≤ 40 mg/dl) and abnormally high triglycerides and LDL (Table 1).

The SL-ASIA acculturation questionnaire was completed by 151 participants. Based on scoring, 42 (26%) were classified to have low acculturation, (ie, very Asian), while 109 (67.7%) were classified to have high acculturation (ie, more westernized).

Association of CAD, T2D and CAD risk factors with acculturation is shown in Tables 2 and 3. On the logistic regression model, without age-adjustment, cholesterol level ≥200 mg/dL ($P=.008$), and BMI≥23 ($P<.046$) were found to be associated with CAD. After age adjustment, ≥10 years stay in the United States ($P=.006$), cholesterol level ≥ 200 mg/dL ($P<.001$), BMI≥23 ($P=.004$), and family history of CAD (0.007) were found to be significantly associated with CAD (Table 2). Similarly for T2D, high acculturation ($P<.0001$), hypertension ($P=.001$), and family history of T2D ($P<.0001$) were associated with T2D, both before and after age-adjustment. CCA-IMT was also found associated with T2D after age-adjustment (Table 3). After age adjustment, the odds of having CAD with family history of CAD was 2.8 (CI 1.322, 6.28) while the odds of having CAD in participants with total cholesterol ≥200 mg/dL was 4.9 (CI 2.12, 11.73) as compared to those without CAD (Table 4).

DISCUSSION

Compared to SAs living in the Indian continent, SAIs have higher rates of several chronic diseases, including CAD. This study supports the available literature on CAD in immigrant populations and emphasizes the role of acculturation in the overall health

Compared to South Asians living in the Indian continent, South Asian Immigrants have higher rates of several chronic diseases, including CAD.

Table 3. Association of T2D, with and without age adjustment, with acculturation and CAD risk factors (outcome variable= T2D)

Variable	Without Age Adjustment		With Age Adjustment	
	Wald Chi-square	*P*	Wald Chi-square	*P*
Acculturation, mostly western vs mostly Asian	7.1756	.007	13.7383	<.001
Length of stay in United States, ≥10 years	.0341	.8534	.0693	.7924
Cholesterol, ≥200mg/dL vs <200 mg/dL	.8468	.3575	1.4084	.2353
History of CAD	1.8149	.1779	3.3898	.0656
Hypertension, ≥120 SBP or ≥90 DBP	6.5988	.010	15.0965	.001
Family history of T2D	12.4853	.0004	18.8956	<.001
Family history of CAD	.4651	.4953	.2462	.6198
Waist circumference, male ≥90 cm; female ≥80cm	.1425	.7058	.0019	.9657
BMI, ≥23.1 vs ≤23	.5401	.4624	1.4978	.2210
Physical inactivity	.629	.4277	.8452	.3579
CCA-IMT	3.3762	.0661	6.3854	.011

T2D, type 2 diabetes; CAD, coronary artery disease; BMI, body mass index.

outcome of SAIs with respect to CAD and T2D.[10–12,15,33–34] For immigrants, acculturation is a response to the challenge of establishing a new identity, norms, socioeconomic status (SES), language, culture, lifestyle and personal attachments.[32,36] The process and extent of acculturation differs among immigrants, with some becoming quite assimilated to their new cultural environment and some adhering almost completely to their native cultural precepts, depending on education, language, family structure, enclave and non-enclave residence. One of the goals of *Healthy People 2010* was to target risk factors for disease and improve health for special populations.[1] The fact that 11.5% of the US population is foreign-born[3–4] suggests that to achieve this goal, the health status of immigrants must be improved as well.

Acculturation has been associated with an increase in risk factors for CAD and T2D in some studies, however there is dearth of literature in this area. Moreover, limited available data is somewhat controversial with respect to prevalence of acculturation, and its association with CAD, T2D and CAD risk factor.[37–40] For example, lack of acculturation has been shown to be an important risk factor for dysglycemia in immigrant Arab Americans.[37] On the other hand, it has also been observed that immigrants' morbidity due to chronic diseases like CVD and T2D increases with increasing length of stay in US.[38–39] Among Hispanics of non-Mexican origin, acculturation has been associated with increased risk for T2D.[40] But fewer studies have included SAIs as one of the high-risk groups in terms of assessing the impact of acculturation on risk factors for CAD and T2D. A study in the Konkani subpopulation of Indians showed acculturation to be a major risk factor for CAD in immigrant populations, but the sample size was not representative of all the other subpopulations of South Asians.[34] Our study findings support the Konkani study results. A small number of studies have shown the association of acculturation with subclinical CAD in multi-ethnic populations.[35–40] But these and other studies mainly measure the level of acculturation using number of years of stay in the United States or some psychological and social parameters.

Table 4. Odds ratio estimates for CAD

Effect	Without Age Adjustment			With Age Adjustment		
	Point Estimate	95% Wald CI		Point Estimate	95% Wald CI	
High acculturation	.489	.149	1.605	.518	.222	1.208
Years of stay in the United States	.076	.005	1.123	.067	.009	.475
Sex, male	.3900	.119	1.280	.334	.155	.717
T2D	2.122	.71	6.338	2.078	.954	4.525
Total cholesterol ≥200mg/dL	5.041	1.514	16.787	4.999	2.129	11.736
Hypertension	1.508	.476	4.775	1.459	.644	3.305
Family history of CAD	2.814	.939	8.427	2.881	1.322	6.28
BMI≥23	.142	.021	.971	.138	.035	.54
Physical inactivity	.667	.174	2.55	.629	.243	1.63

T2D, type 2 diabetes; CAD, coronary artery disease; BMI, body mass index.

Only a handful of studies on acculturation have used the SL-ASIA Scale, a validated scale for acculturation measurement. And to our knowledge, no previous study on SAIs has used the SL-ASIA as a tool to measure acculturation in SAIs.

One of the strengths of this study is a diverse group from three states (Georgia, Kansas and Missouri), which represent a geographically diverse yet culturally homogenous SA population. Second, the SL-ASIA Scale was used to measure acculturation. Third, the outcome of this study emphasizes the need for further research (longitudinal studies) to consider acculturation as a predictor for CAD and T2D in contributing to the overall predisposition to CAD.

Traditional approaches to assess CAD risk are based on quantification of CV risk factors. Several algorithms based on this approach are used.[41–47] A popular one among these is the Framingham Risk Scores (FRS) Model which is extensively used to determine the risk of developing CVD and CAD over a period of 2 years, 10 years and now lifelong risk.[41–43] The FRS developed from the Framingham Heart Study is based on age, total cholesterol, LDL-cholesterol, HDL-cholesterol, blood pressure, smoking status and T2D.[41–42] The FRS equates each risk factor with a % probability of developing CAD over a period of time.[41–44] Once each participant's risk factors have been identified, the total score can be calculated and represents the individual's absolute 10-year risk for developing CAD for example (ie, 10%, 20%). Because Framingham residents are largely Whites of European origin, there is an uncertainty about the ability of the FRS to predict absolute risk for first coronary events when applied in other populations. Validation studies showed inconsistent results across different populations[18,43–47] leading to a debate about the appropriateness of this tool for risk prediction in other populations. In general, the FRS overestimates an individual's absolute risk in external (non-Framingham) populations with a lower occurrence of CAD compared with the Framingham population, and underestimates it in populations with a higher occurrence of CAD.[18,43–46] Based on known ethnic differences in risk prediction, the FRS model accurately predicts CAD risk among Whites and Blacks living in the US.[43] For Americans of Japanese and Hispanic descent and for Native Americans, the model overestimates CAD risk. Although used extensively and generally accepted, this model (as well as other algorithms based on similar approaches) has limitations. Family history, abdominal adiposity, inflammation, CCA-IMT and other factors shown to predict CV risk are not incorporated in the FRS.[43–46] Diabetes and smoking are identified only as present or absent, although current evidence supports a continuous relationship between glycemia and tobacco exposure to CAD risk.[41–43,48] Age is the overriding FRS determinant, ignoring the greater inter-individual variation in atherosclerotic burden at older ages and often providing false reassurance at younger ages.[48] Importantly, for use in immigrant populations, impact of acculturation and immigration on CAD is not considered.[44–47]

Early detection of subclinical CAD, for example, in high-risk South Asians at a young age could help prevent CV events and substantially reduce the level of death and disability attributable to CAD. Imaging of arteries to identify and quantify the presence of subclinical atherosclerosis has been suggested to further refine CV risk assessment. Limited published data are available on the associations of CCA-IMT with acculturation in South Asians, especially in SAI groups. Anand et al performed a cross-sectional population study in 1015 Canadian adults of Caucasian European, South Asian, Chinese and Aboriginal ancestry. [48] This study showed that 22% of SAIs who were categorized as low risk based on FRS had CCA IMT values of $\geq$75th percentile for age, sex and ethnicity. Moreover, positive CCA-IMT was also found to be associated with pro-inflammatory HDL adjusting for age, family history of CVD and hypertension in our earlier study, (P=.030) however, association of acculturation with CCA-IMT was not significant in this current study and could be attributable to a small sample of CCA-IMT participants.

Considering the high percentage of immigrants in the United States, and the burden of CVD and T2D they bring with them, acculturation should be used to estimate their risk factors. Accounting for the immigrants will be a true representation of US population and hence, this population and the factors unique to migration need to be a part of such algorithms and models.[45–48]

There are some limitations of the study that are worth mentioning. First, the study was cross-sectional with a relatively small sample size. Blood work was randomly performed on few immigrants due to limited funds available and this being a pilot study. But these are important findings that call for more validation in larger populations of SAIs. Second, in order to obtain a homogenous group of South Asians, only South Asian Indians following Hindu religion were recruited. Third, participants were recruited from health fairs in local Hindu temples and through Indian Association directories which may not be all inclusive and entirely representative of the South Asian community. However, to our knowledge, there is no database available that can provide census data on SAIs in the United States. Therefore, SAIs were most readily accessible through such community based approaches. Based on the findings in the Hindu SA population, currently more work is underway in Muslims and other ethnic groups as well to better understand on a wider scale the

impact of acculturation on heart disease and T2D. Forth, CAD was diagnosed on history and available medical records of proven CAD diagnosis. Due to limited funds, stress testing and/or other diagnostic tests were not done. Therefore it may be possible that CAD prevalence is underestimated and does not include new cases of CAD. Last but not the least, many of the study participants did not get all testing done that resulted in a different denominator for several blood testing and ultrasound examinations. In addition, due to small sample size and limited funds, more detailed analysis (risk factors adjustment) and expensive testing were not performed on all 159 participants, resulting in differing sample sizes.

CONCLUSION

Given that SAIs are known to carry a disproportionately high risk for CAD and that traditional CAD risk factors may not fully explain the excess risk, there is a need to explore and understand other non-traditional risk factors. SAIs are significantly under-represented in major clinical trials and evidence-based management strategies for prevention and treatment of CAD specifically in this population is lacking. The implication of this study is that compared to other immigrant populations, SAIs in the United States are at higher CAD and T2D risk and immigration and acculturation may play a major role in disease causation. Those SAI with less acculturation appear to have higher prevalence of CAD and its risk factors (ie, obesity, hypertension, hyperlipidemia, and lower prevalence of physical inactivity). It is crucial to identify acculturation factors that have a negative impact on health behaviors and increase the odds of having CVD risk factors in the large and growing US immigrant population. Prospective studies are needed to better understand how acculturation influences health behaviors across different immigrant ethnic groups. In addition, intervention studies that test tailored strategies to improve lifestyle behaviors across diverse ethnic groups of immigrants are needed.

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