Prevalence and Correlates of Cardiovascular Risk Factors in South Asians: Population-Based Data from Two California Surveys

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Objective: Few population-based studies report cardiovascular disease (CVD) risk factor prevalence for South Asians in the United States. We examined CVD risk for South Asians in California.

Design/Setting/Participants: We used data from two population-based surveys with South Asian participants in California, the California Health Interview Survey (CHIS) and the Cardiovascular Health among Asian Indian (CHAI) survey. The CHIS 2001 was conducted in English; 769 South Asians aged 25–83 years participated as one of many ethnic groups. The CHAI survey was population-based but focused on ethnicity-specific characteristics in 304 South Asians aged 25–80 years in English and Punjabi in 2001–2002.

Main Outcome Measures: A CVD risk score included smoking, hypertension, hypercholesterolemia, diabetes, myocardial infarction, and angina. Separate logistic regression models examined the association of sociodemographics, lifestyle, medical risk, acculturation, and ''any CVD risk.''

Results: In CHAI, hypertension (20%), hypercholesterolemia (24%), and diabetes (10%) were high; smoking was low (12%). In CHIS, prevalence of these conditions was lower, except smoking (21%). Approximately 35% of participants in each survey had any CVD risk. Male sex, age, higher body mass index, education less than a bachelor's degree, and alcohol use were associated with CVD risk in both studies. The CHAI subjects interviewed in English had higher odds of any CVD risk than those interviewed in Punjabi (odds ratio 10.3, 95% confidence interval 2.9–36.7).

Conclusions: Data from multiple sources add crucial information about heterogeneity of risk within ethnic populations. South Asians in the CHIS had higher rates of smoking, but lower CVD risk scores than participants in the CHAI study. In CHAI, English language use was associated with increased CVD risk score. Additional research should examine if acculturation increases CVD risk. (*Ethn Dis.* 2006;16:886–893)

Key Words: Asian Indian, Cardiovascular Diseases, Immigrant Health, South Asian, Survey Research

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INTRODUCTION

Cardiovascular disease is the leading killer among Americans and is the primary cause of death among South Asians in the United States.[1,2] South Asians, regardless of the country to which they have migrated, have been shown consistently across studies to have higher mortality from coronary heart disease (CHD) than other ethnic groups.[3] This ethnic disparity remains unexplained by traditional cardiovascular risk factors that have been examined.[4] South Asians have also been noted to be at increased risk for insulin resistance (metabolic syndrome), and thus to be at risk for both development of diabetes as well as for development of coronary heart disease.[5–10]

Most of the available published research on heart disease among South Asians has been done in countries other than the United States.[6,11–13] Over the last decade, the South Asian population had the largest growth of any ethnic group in the United States. More specifically, the Asian Indian population in the United States grew by 105% from 1990 to 2000.[14,15] The largest group of South Asians in the United States resides in California.[15] The high

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prevalence of CHD among South Asians and the concomitant rise in the South Asian population in the United States reflect the importance of understanding both the prevalence and the ethnic-specific correlates for CVD in this group in the United States. Determining whether health disparities exist for specific ethnic groups remains critical to addressing community-specific health issues and is a key goal of *Healthy People 2010.*[16]

Large health surveys in the United States often aggregate people into broad race/ethnicity categories that may include many diverse groups. In order to examine health disparities, data should be disaggregated (where possible) or similar health statistics should be collected for smaller categories of people. In order to best understand cardiovascular risk factors in South Asians, we examined data from two studies that were both synergistic and suited to this purpose. The California Health Interview study (CHIS), a California-wide study, provides disaggregated data on South Asians as one of many ethnic groups oversampled in 2001. The CHIS assessed several sociodemographic, lifestyle, and medical history characteristics. The Cardiovascular Health Among Asian Indians Survey (CHAI), an ethnic-specific

study, assessed these and additionally assessed basic acculturation factors. Our study's aim was to examine whether the same correlates (sociodemographic, lifestyle, and medical history) were associated with cardiovascular risk in two distinct groups of South Asians in the United States.

METHODS

CHIS Survey

In 2001, the California Health Interview Survey (CHIS), a survey of >55,000 households in California, oversampled South Asians (as well as other Asian populations). Thus, the data from the 2001 CHIS provide a unique opportunity to assess the cardiovascular risk factors of South Asians in the United States by using a population-based random sample.[17] A full description of the sampling and weighting procedures used in the CHIS study has been described previously; this study uses the weights published in April 2004.[17] In brief, CHIS is a random-digit dial (RDD) telephone survey of households drawn from every county in California. The CHIS sample is representative of the state's noninstitutionalized population living in households. In addition to the above RDD methods, to enable researchers to make population-based estimates of several smaller subgroups, CHIS investigators used surname lists to identify 2100 additional Asian households. In sum, 844 South Asian adults were sampled from both the original RDD household survey and the list-driven oversampling in CHIS. These two groups form the analytic cohort from CHIS. The age range of the CHIS study included adults ≥18 years of age; however, the CHAI study sampled only adults ≥25 years of age. In order to make valid comparisons between the CHIS and CHAI cohorts, we restricted the CHIS cohort to participants age ≥25 and older (*n*= 769). Response rates to telephone

surveys have declined over the past few years. The CHIS uses the American Association for Public Opinion (AAPOR) system to calculate the response rate.[18] The overall unweighted AAPOR response rate 4[18] for CHIS was 43.3%, the weighted response rate was 37.7%, and the completion rate was 30.5%.[19] All CHIS study subjects gave informed consent, and this study was approved by the institutional review board (IRB) at the University of California, Los Angeles.

CHAI Survey

The Cardiovascular Health Among Asian Indians (CHAI) survey sampled participants from three areas within northern California identified as having proportionately higher South Asian populations. These included communities where participants have access to South Asian religious and cultural institutes and businesses that cater to South Asians. We chose to conduct the survey in Punjabi as well as English to best assess health status of South Asians in the more rural community. Local community people, students, and in some cases, community advisors served as translators, transcribers, and interviewers for surveys. The research project has been previously described; briefly, we surveyed 304 adults by using a list-driven, surname-based approach consistent with other studies of Asian sub-populations.[20,21] No subjects were excluded from the CHAI sample as long as they were adults (ages ranged from 25–80) and they defined themselves as South Asian, Asian Indian, or Pakistani. All research protocols were reviewed and approved by the University of California, Berkeley, Committee for the Protection of Human Subjects and the Centers for Disease Control and Prevention (CDC) IRB.

Most of the CHAI survey was based on the 1999 Behavioral Risk Factor Surveillance Survey (BRFSS) using the sections of the survey most closely related to cardiovascular health as well

as sections on healthcare access and demographic information. The BRFSS is a CDC-sponsored survey done in all 50 states and the District of Columbia annually as a RDD telephone survey. Survey items were added or modified from BRFSS based on advisory board input and focus group results.[21] Once instruments were finalized, they were forward and backward translated into Punjabi. In one community, we also wanted to examine whether specific features (such as delisting or low telephone penetration) of that area might influence our ability to successfully conduct a population-based telephone survey in a rural community. Accordingly in this community only, the survey workers interviewed people both in person and via telephone to assess any differences in telephone accessibility.

The CHAI telephone list sample was developed by working with Genesys (Marketing Systems Group, Ft. Washington, Pa) to construct a list of common Asian Indian surnames, which would include names common across a variety of South Asian regions and diverse religious backgrounds. A telephone list sample was then drawn from three area codes with communities known to have a proportionately higher density of South Asians. Using a subsample of the list-generated phone numbers, we phoned each number up to 12 times. The CHAI interviewers contacted any South Asian member of the household ≥25 years of age who agreed to be interviewed. Survey workers were told to try to reach approximately equal numbers of men and women; however, the final sample included more women than men. Calls were generally conducted by workers who were bilingual in Punjabi; rural community participants who indicated a preference for being interviewed in Punjabi were interviewed by a single community worker. Of the participants eligible to participate in the telephone

study, the Council of American Survey Research Organizations (CASRO) response rate 3[18] was 62.9%. While AAPOR and CASRO rates are not exactly interchangeable given formula differences,[37] in comparison to the CHIS, the CHAI study had a better response rate among the South Asian ethnic population in California.

SAMPLE CHARACTERISTICS

South Asian Race/Ethnicity

For both surveys, South Asians were primarily identified through self-report of race/ethnicity using definitions from the 2000 US Census. In addition, if participants identified that their origins were from India, Pakistan, Sri Lanka, Bangladesh, Bhutan, or Nepal, they were also considered South Asian. Both the CHAI and CHIS surveys used surname-based lists provided by Genesys during roughly the same time period. However, the surname list developed for the CHAI study additionally drew from two Asian Indian surname lists supplemented with directory-listed surnames and researcher-added surnames from the CHAI catchment area and from team members. Thus the CHAI study may have included a more complete sampling frame of surnames than the CHIS study.

Sociodemographic Information and Healthcare Access

Basic demographic information including age, sex, marital status, level of education, household income and household size were assessed in both surveys. The questions included in CHIS that ascertained an individual's access to care included questions about current health insurance, the number of medical doctor visits in the past year, and whether the individual had a usual place to go to when sick. Similarly in CHAI, questions ascertained current health insurance of any type, whether health insurance was lost in the past

12 months, and whether individuals had a primary healthcare provider. The importance of having a medical home (primary care provider) has been documented in previous studies as a determinant of access to prevention screening and access to treatment.[38–40]

Cardiovascular Conditions and Risk Factors

Cardiovascular conditions and risk factors were assessed by self-report. Respondents were asked to report past physician or healthcare provider diagnoses of diabetes mellitus, high blood pressure, hypercholesterolemia, or heart disease (eg, myocardial infarction [MI], angina). Weight and height were also self-reported, and body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters squared). We then built a composite CVD risk score by adding up the number of risk factors identified (tobacco use and history of provider-diagnosed diabetes, hypertension, hypercholesterolemia, MI and angina, or stroke). This method has been used in other cardiovascular risk and epidemiology studies.

STATISTICAL METHODS

The prevalence of characteristics and CVD risk factors were calculated for the CHIS and CHAI cohorts separately. The associations of characteristics and any CVD risk factor were examined by using bivariate statistics, chi-square tests for categorical responses and t tests for continuous characteristics. Final parsimonious models of CVD risk were calculated for the CHIS and CHAI studies separately. For the CHIS study, characteristics associated with any CVD risk at a P value ≤.20 were included in the model. Study weights were applied by using a Taylor series ranked weighting procedure in SUDAAN Version 9.0 (RTI International, Research Triangle Park, NC), in order to accommodate

this survey's complex dual sampling frame. For the CHAI model, because of constraints of sample size in the CVD group, backward stepwise regression was employed to eliminate variables with $P≥.05$. Analyses for the CHAI study were carried out with SAS version 8.02 (SAS Institute, Cary, NC). Linear splines are a technique used to interpolate a line through multiple points. We used this method to draw a smoothed curve of any CVD risk factors for each level of BMI. Through examination of the linear spline, we can determine whether a potential threshold effect occurs for BMI with any CVD risk factors. These linear splices are calculated by using generalized additive models that were adjusted for other significant covariates with S-Plus version 6.1 (Insightful Corp, Seattle, Wash).

RESULTS

A total of 769 South Asians age 25–83 years were surveyed by telephone in CHIS, while in CHAI 252 South Asians were interviewed by telephone and 52 were interviewed in person (Table 1). The CHIS participants tended to have more years of education, higher income, higher employment, and had lower rates of having a primary care physician compared to the CHAI participants. Individuals interviewed in CHIS were more likely to exercise regularly and had lower mean BMI but had a higher prevalence of ever smoking compared to CHAI participants (21% vs 12%, $P<.001$). The CHIS participants had a lower prevalence of physician-diagnosed hypertension (13% vs 20%, $P=.007$) and diabetes (4% vs 10%, $P=.001$). Only a subgroup of CHIS participants with coronary heart disease or hypertension were asked about a physician diagnosis of hypercholesterolemia, which made a direct comparison of prevalence between the two surveys difficult. However, more CHIS

Table 1. Characteristics of the CHIS and CHAI subjects by interview-type*

	CHIS	CHAI	
	Telephone *n*=769†	Telephone *n*=252	In person *n*=52
Male sex	428 (55)	109 (43)	17 (33)
Age, years (median, range)	41 (25 – 83)	41 (25 – 79)	38 (25 – 80)
Married	611 (92)	216 (87)	44 (85)
Education less than a bachelor's degree	131 (22)	61 (24)	30 (57)
Income <$50,000	205 (30)	59 (23.4)	21 (40.4)
Employed‡	591 (78)	111 (44.1)	20 (38.5)
Current health insurance	710 (89)	215 (86)	47 (90)
Have primary care MD	483 (67)	202 (80)	51 (98)
English language interview	(100)	227 (90)	27 (52)
Health-related behaviors			
Any alcohol in 30 days	352 (45)	92 (41)	18 (64)
Smoked ≥100 cigarettes/beedis	148 (21)	33 (13)	3 (6)
Regular moderate-vigorous exercise	553 (73)	170 (68)	21 (40)
Fruit and juice intake per week	9.5 ± 6.4	9.8 ± 7.3	7.3 ± 5.3
Vegetable intake per week§	8.9 ± 6.4	11.3 ± 7.6	10.0 ± 7.5
Vitamin use in past month	396 (51)	114 (48)	30 (58)
Medical history			
BMI, kg/m^2	24.5 ± 5.5	25.6 ± 5.2	25.8 ± 6.0
High blood pressure	105 (13)	51 (20)	11 (21)
High cholesterol	41/121 (31)‖	60 (32)	12 (52)
Diabetes	37 (4)	27 (11)	5 (10)
Heart disease (MI or angina)	31 (6)	7 (3)	3 (6)
Self report of health:			
Poor/fair	45 (6)	31 (12)	17 (33)
Good	231 (21)	78 (31)	17 (33)
Very good/excellent	493 (66)	143 (57)	18 (35)

* *n* (%) or mean ±SD are reported for each category.
† Excluding 75 participants from CHIS between ages 18 to 24 years.
‡ Not including self-employed participants.
§ Vegetables included salad greens and vegetables excluding potatoes.
‖ Question was asked only in subjects who reported coronary heart disease and/or hypertension.
BMI=body mass index; CHAI=Cardiovascular Health in Asian Indians Study, 2001–2002; CHIS=California Health Interview Survey, 2001; MI=myocardial infarction.

participants reported very good or excellent overall health status than CHAI participants (66% vs 53%, *P*<.001).

Of the participants interviewed in CHAI, 252 (83%) were interviewed by telephone, and 254 (83.6%) were interviewed in English (Table 1). Of the 52 individuals interviewed in person in CHAI, approximately half chose to be interviewed in their native language of Punjabi. Individuals interviewed by telephone were more likely to be male, have more education, have higher income, and participate in regular exercise. They also had higher intake of fruit, juice, and vegetables and lower prevalence of physician-diagnosed hypercholesterolemia and heart disease.

However, these individuals were also more likely to report having smoked ≥100 cigarettes. The in-person and telephone-interviewed participants in CHAI had a similarly high prevalence of physician-diagnosed high blood pressure (20%) and diabetes (10%).

We summed the number of known CVD risk factors (ever smoking ≥100 cigarettes, hypertension, diabetes, or hypercholesterolemia) or existing CHD (history of MI or angina) in each survey. The figure displays the proportion of individuals in each survey within each category of cumulative known CVD risk factors. Approximately 35% of participants in both surveys had one or more CVD risk factor (*P*=.52, comparing the distribution between both surveys).

Table 2 displays the bivariate associations between each sociodemographic and health-related variable and presence of any cardiovascular risk factor. In both the CHIS and CHAI studies, male sex, age, education less than a Bachelor's degree, BMI, and regular exercise were associated with the presence of any CVD risk factor. For the CHIS study alone, additional variables associated with any CVD included employment and any alcohol use in past 30 days. In CHIS, rating one's health as very good or excellent was associated with presence of no cardiovascular risk factors (*P*=.009), and in CHAI, being interviewed in English was associated with any CVD risk (*P*=.0003).

In CHIS the final multivariate model suggests that age, male sex, education less than a bachelor's degree, and any alcohol use in the past month were significantly associated with any CVD risk, while self-report of very good or excellent health was associated with no reported CVD risk (Table 3). Those who reported fair or poor health had a trend toward increased odds of any CVD risk, as did those with higher BMI. In CHAI, age, male sex, BMI, and being interviewed in English were significantly associated with presence of any cardiovascular disease risk factor. We examined BMI with linear splines and found no significant threshold effects in adjusted models. Thus, the two final multivariate models suggest that sociodemographic and lifestyle correlates were associated with any CVD risk.

DISCUSSION

South Asians represent a growing, relatively well-educated, middle-upper socioeconomic segment of the diverse ethnic minority makeup of California. Despite having sociodemographic and lifestyle characteristics that have been traditionally associated with better
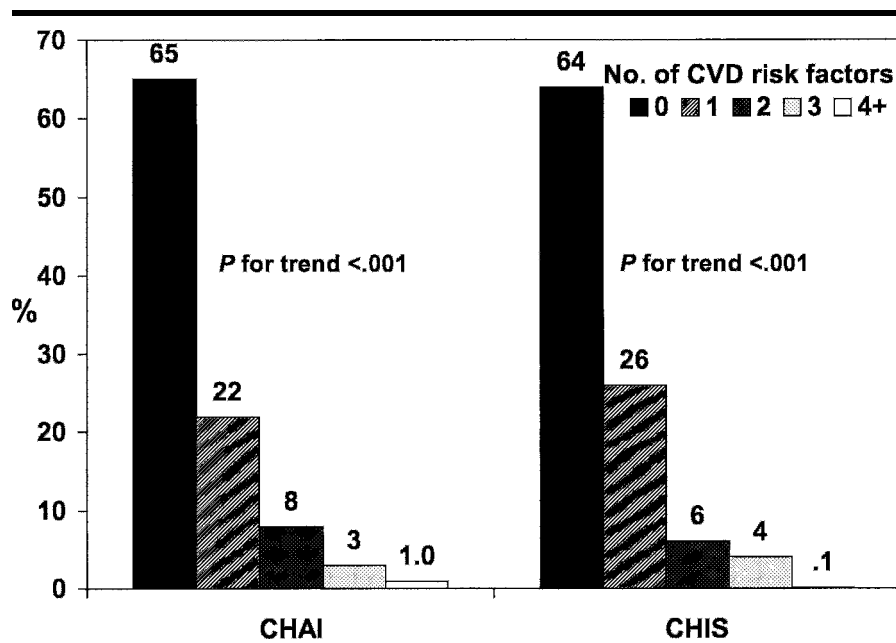
Fig 1. Distribution of number of known cardiovascular risk factors in the CHAI and CHIS population. A cardiovascular disease risk included high blood pressure, diabetes, high cholesterol, smoked more than 100 cigarettes in lifetime, or history of myocardial infarction or angina. CVD=cardiovascular disease; CHAI=cardiovascular health among Asian Indian; CHIS=California Health Interview Survey

health status in the majority population,[9,22] we found that South Asians had a high prevalence of known cardiovascular risk factors. South Asians interviewed in a statewide survey conducted in English had a similar prevalence of risk factors as the overall California population. However, South Asians interviewed in a smaller, ethnicity-specific survey conducted in both English and Punjabi had higher rates of hypercholesterolemia and diabetes than the US average. This

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disparity between the two surveys performed in South Asians may be explained by differences in acculturation, measured by use of English language during the CHAI interview.

Most clinical studies of South Asians have found that the rates of smoking, hypertension, and hypercholesterolemia are similar to or lower than those of comparative White European populations,[9,23,24] while diabetes rates are significantly higher for South Asians.[25] However, these traditional cardiac risk factors cannot fully explain the higher rates of cardiovascular disease among South Asians.[4] In a recent population-based study of South Asians in Canada, Anand et al reported that South Asians had the highest prevalence of cardiovascular disease compared with Europeans and Chinese (11% vs 5% and 2% respectively, $P<.001$).[23] South Asians had increased prevalence of all major cardiac risk factors and greater abnormalities in prothrombotic and inflammatory factors. In multivariate regression analysis that included all traditional

cardiac risk factors, atherosclerosis measurements, and novel risk factors, South Asian ethnicity was independently associated with a four-fold increased odds of cardiovascular disease (odds ratio 4.51, 95% confidence interval 1.46 – 13.89, P=.02).[23] Unfortunately, this study was not conducted in non-English languages, and factors associated with acculturation were not measured as possible mediators of the increased cardiovascular disease risk among South Asians. Similarly, in a recent review on diabetes and cardiac disease in South Asians, several risk factors are described; however, the review documents that prospective intervention studies on this population are lacking.[10]

We found that use of English language during the CHAI interview was associated with higher odds of having any CVD risk factors. In many studies, acculturation, measured variably as number of years post-migration or language spoken or via acculturation scales has been associated with increasing rates of diabetes and heart disease.[13,26,27] However for South Asians, the risk of coronary heart disease and metabolic syndrome seems to track independently of acculturation throughout the diaspora.[28] Increased affluence and westernization has been associated with an increase in the prevalence of diabetes in many indigenous populations.[27,29] In developed countries, persons of lower socioeconomic status have a higher risk of obesity and type 2 diabetes.[30] Surrogates of socioeconomic status such as attained education and income[31,32] have been shown to be inversely associated with diabetes and heart disease risk.[22] Psychosocial factors such as stress emerged among the nine most explanatory risk factors in the recent worldwide INTERHEART study of MI.[33]

Studies in certain Asian populations have shown an increase in CHD risk and a decrease in hypertension with migration.[34,35] One explanation for the CHIS findings would be that South

Table 2. Bivariate association with any cardiovascular disease risk factor*

	CHIS		CHAI	
	n/N (%)†	*P* value	*n/N* (%)†	*P* value
Male sex	188/428 (44)	<.001	69/126 (55)	<.001
Age	–	<.001	–	<.001
Married	190/611 (34)	.33	94/260 (36)	.17
Education less than a bachelor's degree	53/253 (33)	.003	22/91 (24)	.01
Income <$50,000	73/205 (42)	.22	17/80 (21)	.26
Other/not employed	198/591 (38)	.02	15/67	.41
Homemaker			17/55	.64
Current health insurance	234/710 (35)	.60	99/276 (36)	.16
Have primary care physician	160/483 (35)	.92	88/253 (35)	.92
English language interview	NA		99/254 (39)	<.001
Any alcohol in 30 days	146/352 (44)	.006	45/110 (41)	.58
Regular moderate-vigorous exercise	116/344 (34)	.14	74/191 (39)	.06
Fruit and juice intake per week	–	.72	–	.45
Vegetable intake per week	–	.84	–	.36
Vitamin use in past month	129/396 (36)	.97	50/141 (35)	.77
BMI, kg/m^2	–	<.001	–	<.001
Self report of health:				
Poor/fair	28/45 (70)	.009	15/48 (31)	.59
Good	128/276 (49)	ref	34/95 (36)	ref.
Very good/excellent	125/493 (29)	.001	56/161 (35)	.87

* Cardiovascular disease risk defined by the following criteria: high blood pressure, diabetes, high cholesterol, smoking >100 cigarettes in lifetime, or history of myocardial infarction or angina.

† *n/N* (%) represents the proportion of participants in each survey who had the characteristic of interest and one or more cardiovascular disease risk divided by all of those with the characteristic; no value provided for continuous variables.

NA=not applicable; BMI=body mass index; CHAI=Cardiovascular Health in Asian Indians Study, 2001–2002; CHIS=California Health Interview Survey, 2001.

Table 3. Multivariate associations with risk for cardiovascular disease* for CHIS and CHAI

	CHIS	CHAI†
	OR (95% CI)	OR (95% CI)
Age (per year)	1.06 (1.03 – 1.08)	1.10 (1.07 – 1.14)
Male sex	2.63 (1.44 – 4.79)	3.36 (1.79 – 6.34)
BMI (per kg/m^2)	1.02 (.97 – 1.07)	1.06 (1.00 – 1.12)
Education less than a bachelor's degree	2.06 (1.11 – 3.83)	–
Any alcohol use in past month	1.84 (1.13 – 2.98)	–
Overall health (vs good)		
Poor/fair	2.17 (.93 – 5.05)	–
Very good/excellent	.53 (.29 – .96)	–
Regular moderate/vigorous exercise	1.54 (.81 – 2.92)	–
Currently employed	1.32 (.68 – 2.55)	–
Interviewed in English (vs Punjabi)	NA	10.31 (2.90 – 36.72)

* Cardiovascular disease risk defined if participant had one or more of the following criteria: high blood pressure, diabetes, high cholesterol, smoked >100 cigarettes in lifetime, or history of myocardial infarction or angina.

† CHAI model is also adjusted for type of interview (in-person vs telephone).

BMI=body mass index; CHAI=Cardiovascular Health in Asian Indians Study, 2001–2002; CHIS=California Health Interview Survey, 2001. MI=myocardial infarction; NA=not applicable.

Asians living in the United States actually have fewer risk factors. However, no other Canadian or US study has found this pattern for coronary heart disease risk among South Asians. The South Asian population may be heterogeneous; individuals from India, Pakistan, and Bangladesh may have differential coronary heart disease risks. Therefore, we must continue exploration of prevalence of risk factors for South Asians in the United States, further examining heterogeneity within South Asians with both population-based and ethnicity-specific survey methods. One mechanism would be to expand ethnicity data collected in the BRFSS to allow for this type of analysis, which was another recommendation of *Healthy People 2010*.[16]

These two data sets had a number of differences, and each set had some limitations. Strengths of both databases included the large samples of South Asians, population-based sampling methods, and a relatively low non-response rate. However, the sampling differed in the two studies; while some differences may indicate that a subset of persons was missed by CHIS (for instance, South Asians who are not able to complete the CHIS survey in English), other differences may relate specifically to sampling bias. For instance, CHAI surveyed a much narrower geographic area, had a more extensive sampling frame, and over-sampled rural-dwelling persons who may have very different characteristics compared with urban-dwelling South Asians who have telephones in California. In addition, CHAI used mixed methods (qualitative and quantitative methods were both used and complemented each other), which allows the researcher to triangulate across methods to compensate for biases inherent in any one method. Telephone interviewing has been criticized in the past for missing households without phones who theoretically may be lower income. However, rates of telephone penetration

in Asian households in California have been reported as higher than in the overall population.[36] And the CHIS represents one of the best datasets to date on South Asians living in the United States. The University of California worked to get broad state coverage (every county, rural and urban), and aimed for a broad range of languages (although no South Asian languages). One mechanism for ascertaining the direction of bias would be to supplement a future CHIS with interviews in a variety of South Asian languages. Although this undertaking would be expensive, with appropriate weighting strategies performing a limited number of interviews in South Asian languages may be possible. The CHIS also collected data on South Asians in 2003; however, we did not use these data because of differences in survey questions asked as well as an interest in keeping the timeframe of the two surveys roughly the same.

While other US studies have examined cardiovascular disease risk factors among South Asians, the two surveys analyzed in the current study represent the only population-based samples of South Asians in the United States. However, neither survey in our study collected data on medications used for CVD risk factors. The CHAI study had a total sample size of 304, and therefore we did not have adequate power to examine the potential graded or dose-response effects of CVD risk factors. If population-based sampling weights by study year were available, future studies could combine data across subsequent administrations of the CHIS (2001, 2003) and pool data with ethnicity-specific studies such as the CHAI survey, thereby retaining confidentiality and also increasing power to detect differences across a heterogeneous (urban/rural) sample.

Prevalence bias might also be introduced into samples by dependency on self-report. Since other items asked pertain to health screenings, which are then used to calculate "reported conditions," a lack of screening access may artificially lower the self-reported rates obtained for conditions such as hypertension, hypercholesterolemia, and diabetes. Similarly, items may be ordered such that not all interviewees answer every item. For instance the "ever diagnosed with high cholesterol" item was asked of all persons who answered they had ever been screened in CHAI while for CHIS, this item was asked only for those already diagnosed with heart disease or hypertension. Since the rural sample in CHAI was less likely to be insured, they may have had less access to screening. Similarly a younger sample might not access the health system as often as an older population.

In conclusion, we found that the prevalence of certain CVD risk factors such as hypercholesterolemia and diabetes were high relative to the overall US population in the CHAI survey, while hypertension and smoking were similar or lower. On the contrary, South Asians in CHIS had lower prevalence of most traditional cardiovascular disease risk factors except for having ever smoked or having high cholesterol. While the sociodemographic variables and lifestyle variables associated with presence of any CVD risk factor were similar to those observed in other ethnicities, use of English language in CHAI was strongly associated with increased odds of having a CVD risk factor. Future studies should develop and validate acculturation measures, such as years post-migration, or acculturation scales to examine whether acculturation to the American lifestyle may be associated with an increased CVD risk for this and other ethnic groups.

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