VIEWPOINT AND COMMENTARY

Report of a National Heart, Lung, and Blood Institute Workshop: Heterogeneity in Cardiometabolic Risk in Asian Americans in the U.S.
Opportunities for Research

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The Asian and Pacific Islander population (Asian Americans) in the U.S. has increased dramatically in the last few decades. Yet, data on cardiovascular disease (CVD) in this population are scarce. The National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health conducted an Expert Workshop to: 1) assess the importance of studying CVD in Asian Americans in the U.S.; and 2) consider strategic options for further investigations of CVD in this population. There is considerable geographical, ethnic, cultural, and genetic diversity within this population. Limited data also suggest striking differences in the risk of CVD, obesity, type 2 diabetes mellitus, and other CVD risk factors across the Asian-American population. The Asian-American population is a new diverse pool with less contemporary genetic and cultural admixture relative to groups that have lived in the U.S. for generations, plus it is diverse in lifestyle including culture, diet, and family structure. This diversity provides a window of opportunity for research on genes and gene-environment interactions and also to investigate how acculturation/assimilation to U.S. lifestyles affects health and CVD risk among relatively homogenous groups of recent immigrants. Given the heterogeneity in body weight, body size, and CVD risk, the Asian-American population in the U.S. offers a unique model to study the interaction and relationships between visceral adiposity and adipose tissue distribution and beta cell function, insulin resistance, and atherosclerosis. (J Am Coll Cardiol 2010;55:966–73) © 2010 by the American College of Cardiology Foundation

Contributing to the rapidly expanding diversity of the U.S., the Asian and Pacific Islander population (Asian Americans) in the country grew 6 times faster than the general U.S. population in the 1990s (1). Considerable geographical, ethnic, cultural, linguistic, and genetic diversity exists within the Asian-American population in the U.S., with 60 different ethnicities that speak >100 different languages and dialects (1). Asian Americans represent 25% of all foreign-born people in the U.S., with 88% of Asian Americans being either foreign-born or having at least 1 foreign-born parent (2).

Striking differences in the risk of cardiovascular disease (CVD), obesity, type 2 diabetes mellitus, and other CVD risk factors across the Asian-American population, based on the limited data available, reflect their underlying diversity and heterogeneity (3,4). For example, Asian Indians, Japanese, and Filipinos have high rates of type 2 diabetes without correspondingly high rates of obesity (5–7), whereas Pacific Islanders have high rates of both diabetes and obesity (3,4). Asian Indians have proportionally higher...
cardiovascular mortality rates when compared with Caucasians, despite higher levels of education and income (8). Pacific Islanders in Hawaii have higher mortality rates compared with the general population of the state and to that of the U.S. overall (9).

Responding to the growing size and diversity of the Asian-American population in the U.S. and to the observed variations in the rates of CVD, diabetes, and body size across this population, the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) held a workshop from August 7 to 8, 2008, in Bethesda, Maryland, to address the following 3 questions concerning Asian Americans in the U.S. 1) What is the population of interest? 2) Why should we study CVD in Asian Americans? 3) What are the strategic options for further investigations of CVD in this population?

What Is the Population of Interest?
The population of interest comprises persons living in the U.S. who identify themselves as Asian or Pacific Islander or using the U.S. Census definitions: an Asian being a person who has origins in the Far East, Southeast Asia, or the Indian subcontinent (10); and a Pacific Islander being a person with origins in Hawaii, Samoa, or any other Pacific Island (11). The term Asian refers to the definition of continents, and does not adequately differentiate across the diverse heritage and cultures of the peoples (e.g., Filipinos have a cultural history different from that of South Asians). Nevertheless, in 2000, there were 12 million Asians (10) and 874,000 Pacific Islanders (11) in the U.S., and in 2006, these numbers grew to 15.2 million and 1 million, respectively (12).

The major Asian groups, comprising >90% of the Asian population residing in the U.S., are Chinese, Filipino, South Asian, Korean, Vietnamese, and Japanese (Fig. 1), and the major Pacific Islander groups are Native Hawaiians and Samoans. The Asian population grew by 72% and Pacific Islanders by 140% between 1990 and 2000, while the total U.S. population grew by only 13% (1). In the 1990s, the Asian-Indian population doubled, the Vietnamese population increased by 80%, and the Filipino population increased by 50%, all mostly due to new immigration. Twenty-five percent or more of immigrant Chinese or Pakistanis arrived within the last 10 years (13–17).

Asian Americans comprise a very diverse group, with origins from >60 countries, representing several linguistic groups, and considerable cultural and genetic diversity. The demographic and socioeconomic profile of this population also shows diversity in age distribution, education, and income.

Age distribution. Although Asian Americans are similar in age structure (or distribution) to whites, blacks, American Indians, and Hispanics, there are a few exceptions. Compared with other Asian-American subgroups, Japanese have an older age distribution, with 31% over the age of 65 years compared with just 5% of the Asian Indian population.

Education. Adults in the Native Hawaiian or Other Pacific Islander (NOHPI) subgroup have the lowest proportion of adults with a bachelor’s degree or higher (29%), whereas at least 45% of all other Asian subgroups have this level of education. Overall, Asians and NOHPI have higher proportions of adults with a bachelor’s degree compared with white, black or African-American, American-Indian or Alaska-native, and Hispanic subgroups.

Income. More than 75% of Japanese, Filipino, and Asian Indian adults have higher average incomes (200% of the poverty threshold or greater), a higher proportion than black or African American, American Indian or Alaska native, and Hispanic subgroups.

Why Should We Study CVD in Asian Americans?
What is the significance of studying this population to the general health and welfare of the U.S.? Asian Americans...
represent a rapidly growing and relatively young (due to large proportion of new immigrants and high birth rates) population in the U.S. The health of this population has major implications for the future of public health cost. Furthermore, this population offers a number of significant, unique, and time-limited scientific opportunities for research into the causes and prevention of cardiometabolic diseases, being predominantly a new and diverse immigrant population in the U.S. The majority of Asian Americans are foreign-born, with the exception of Japanese, the majority of whom are U.S. born (the proportion of native- and foreign-born are as follows: Chinese 19:81, Filipino 32:68, Asian Indian 7:93, Vietnamese 8:92, Korean 11:89, other 30:70). Thus, Asian Americans offer a new diverse pool with less contemporary genetic and cultural admixture relative to groups that have lived in the U.S. for generations, plus diversity in lifestyle including culture, diet, and family structure. This diversity provides a window of opportunity for research on genes and gene-environment interaction before acculturation, assimilation, and interracial marriages dilute the relatively homogenous groups of recent immigrants.

Of considerable interest is the opportunity that the Asian-American populations offer to further understand the link between CVD, type 2 diabetes, and body size. Review of scarce available data suggests large variations across Asian-American groups in the occurrence of these conditions, with interesting patterns of disparity.

The only nationally reported representative data on obesity, CVD, and diabetes in Asian-American groups are from the National Health Interview Survey (NHIS) (3). These data are invaluable but have several limitations. The NHIS is based on self-report and does not include examinations or laboratory tests. Therefore, it is likely that the prevalence of CVD and diabetes is underestimated, and the potential bias in reporting body weight across groups is not known. Assessment of the prevalence of hypertension, dyslipidemia, and other factors that need clinical evaluation is not possible from these data. Furthermore, these cross-sectional data do not allow for assessment of change, incidence of outcomes, or inference of causality. Moreover, the NHIS sample sizes for subgroups are small (less than a few hundred for each group) and do not allow reliable estimates for all subgroups.

These limitations aside, the self-reported national data strongly suggest ethnic differences in diagnosed diabetes and heart disease rates, which appear to be highest among Asian Indians and Filipinos and lowest among Koreans, Vietnamese, and Chinese in the U.S. (Fig. 2). Interestingly, Asian Indians do not have correspondingly high prevalence of obesity (body mass index [BMI] ≥30 kg/m²). Prevalence of overweight (BMI 25 to <30 kg/m²) and not obesity, however, appears to be higher among Asian Indians and Filipinos compared with Chinese and Vietnamese.

Data from regional studies, which suffer from widely differing methods and population selection, also suggest wide variations in the prevalence of cardiometabolic diseases and risk factors across Asian groups. For example, the prevalence of CVD ranged from 0.3% to 27.8% (18,19) and that of diabetes from 3.5% to 47% (20,21). Some data also suggest a higher prevalence of hypertension among Japanese and Filipinos compared with a relatively lower prevalence among Chinese and Koreans (NHIS). The highest preva-

![Figure 2 Prevalence of Self-Reported Overweight, Obesity, Diabetes, and Heart Disease](https://example.com/figure2)

**Figure 2** Prevalence of Self-Reported Overweight, Obesity, Diabetes, and Heart Disease

Prevalence of self-reported overweight (blue bars), obesity (red bars), diabetes (green bars), and heart disease (purple bars) among Asian subgroups in the U.S. Data adapted from Barnes et al. (3). Overweight = body mass index 25.0 to 29.9 kg/m²; obese = body mass index ≥30.0 kg/m². Heart disease includes coronary heart disease, angina pectoris, heart attack, or any other heart condition or disease. All estimates are age-adjusted using the projected 2000 U.S. population as the standard population using 4 age groups: 18 to 24 years, 25 to 44 years, 45 to 64 years, and 65+ years. The following estimates have a relative standard error of >30% and ≤50% and should be used with caution: obesity and diabetes among Koreans; heart disease and diabetes among Vietnamese. **Error bars** represent standard errors. NHOPI = Native Hawaiian or Other Pacific Islander.
lence of smoking is among Korean men and the lowest prevalence is among Asian-Indian men. Although diet and physical activity are important determinants of obesity, diabetes, and CVD, data on these factors in Asian Americans are scarce. Furthermore, few studies have attempted to study acculturation and its effects on CVD risk in the Asian-American population. Based on variations in age at immigration and length of time spent in the U.S., there is a wide range of acculturation even within Asian-American subgroups. There is a paucity of validated acculturation instruments for Asian-American populations, and no instruments that can be used across these diverse groups for purposes of comparison among them.

Are there special opportunities to learn about the mechanisms of atherosclerosis, and on the roles of diet, activity, acculturation, and psychosocial factors, by studying these populations? We review in some detail studies of Japanese Americans, who have been the best studied Asian immigrants to the U.S., and of Filipino Americans, who have been studied only recently with several novel, but preliminary insights related to their cardiometabolic risk factors and disease patterns.

**Japanese Americans.** Japanese Americans comprise the sixth largest Asian ethnic group in the U.S., with migration to Hawaii dating back to 1868. Japanese Americans were found to have a fourfold higher risk of type 2 diabetes compared with Japanese living in Japan (22). This motivated the JACDS (Japanese American Community Diabetes Study) (2,7,23) in the early 1980s that was designed to investigate generational differences in diabetes and CVD risk. The main findings of this study were that larger visceral fat area (but not subcutaneous abdominal fat area) was associated with higher levels of triglycerides and lower high-density lipoprotein (HDL) cholesterol in men and women (24), and was also associated with hypertension (25), nonobesity components of the metabolic syndrome (26), incident diabetes, and coronary heart disease (CHD), independent of age, sex, and subcutaneous fat area (27). Higher animal protein and fat intake were associated with higher diabetes prevalence in second-generation participants (28), and the average BMI in JACDS was lower than in the U.S. population overall (e.g., the National Health and Nutrition Examination Survey data), despite the high incidence of type 2 diabetes.

The NI-HON-SAN (Nippon-Honolulu-San Francisco) study began in 1965 to examine possible differences in stroke and CHD in Japanese living in Japan, Hawaii, and California (29). Many factors potentially related to CVD were similar in California and Hawaii Japanese men (30–34), but these 2 populations differed from the Japanese population in Japan for many factors. Mean serum cholesterol levels were lowest in Japanese living in Japan, as was intake of saturated fat; blood pressure levels were lowest in Hawaii and highest in California; BMI was highest in California and Hawaii and lowest in Japan; cigarette smoking and alcohol intake were both much higher in Japan.

Although the prevalence of stroke was highest in Japan, intermediate in Hawaii, and lowest in California, the prevalence of CHD was highest in California, intermediate in Hawaii, and lowest in Japan (35).

The Honolulu Heart Program (HHP) further evaluated CVD among 8,000 Japanese American men living in Honolulu, age 45 to 68 years, from 1965 to 1968, and examined for the NI-HON-SAN study. Although the risk factor levels of these men had risen to levels similar to those of Caucasians, the stroke and CHD rates remained lower than for Caucasians in the U.S. (36). Several studies have been completed among the offspring of the HHP study participants (37). In 1 study of 1,000 sons and daughters of the HHP cohort (38), it was found that BMI and prevalence of diabetes were much higher in sons and daughters than in their fathers, whereas total cholesterol was lower in sons and daughters.

**Filipino Americans.** Prior studies have reported elevated prevalence of type 2 diabetes among Filipinos, despite the absence of obesity, and hypertension prevalence exceeding that of African Americans (39,40). The University of California San Diego Filipino Health Study was initiated in 1995 to measure the prevalence of and risk factors for CVD, type 2 diabetes, and osteoporosis among self-identified Filipino women, age \( \geq 40 \) years (41). Filipino-American women were enrolled as a comparison group to Caucasian participants from the Rancho Bernardo study, using the same research protocol, staff, clinic, and diagnostic laboratories.

Among the Filipino women, CVD prevalence was 23%, and 71% of CVD cases were previously undiagnosed (42). Diabetes prevalence was 36%, and >50% of these women were unaware of the diagnosis (41). Among women without type 2 diabetes, the Filipinos had a significantly higher prevalence of the metabolic syndrome by every definition, compared with Caucasians (43). Among normoglycemic women, Filipino women had significantly lower adiponectin concentration compared with Caucasians (mean 8.9 \( \mu g/ml \) vs. 15.9 \( \mu g/ml \), even after adjusting for BMI, waist, waist:hip ratio, fasting insulin, or homeostasis model assessment of insulin resistance (44). Low adiponectin concentration, parental history of myocardial infarction, and microalbuminuria were each independently associated with CVD, after adjusting for age, diabetes, hypertension, low-density lipoprotein (LDL) cholesterol, HDL cholesterol, estrogen use, and physical exercise (42).

Compared with the Caucasian cohort, Filipino women had more visceral fat and a higher prevalence of type 2 diabetes, hypertension, and the metabolic syndrome. However, the prevalence of subclinical atherosclerosis in women, estimated by coronary artery calcium (\( \geq 150 \)) did not differ between Filipino women (22%) and Caucasian women (20%) (45). The CVD risk factors that differed by ethnicity included older age, more smoking, and elevated total-to-HDL cholesterol ratio among Caucasians, and more diabetes and hypertension among Filipino women. Filipinos had
investificantly more visceral adipose tissue at every level of waist girth (5).

An acculturation questionnaire, based on a modified instrument adapted from the questionnaire used by the San Antonio Heart Study among Mexican-Americans, was used to assess childhood and adult English use and proficiency, and traditional beliefs. Strong traditional values were associated with an increased risk of cardiovascular disease and myocardial infarction, possibly reflecting the stress associated with maintaining such values during acculturation and assimilation (E. Barrett-Connor, M. Araneta, D. Morton, unpublished data, August 2008).

What Are Strategic Options for Further Investigations of CVD in This Population?

As the proportion of non-Caucasian persons in the U.S. increases, it is important that we systematically study and better understand underlying genetic and pathophysiological differences across race/ethnic groups and the changes in health status that accompany acculturation. An analysis of the nationally representative NHIS data showed that Asian Indians had the highest ethnic-specific self-reported diabetes prevalence (ranging from 6% to 7% among the normal weight, to 19% to 33% among the obese), and had 2 to 3 times the odds of reporting diabetes compared with non-Hispanic whites (46). The studies of the Japanese and Filipino populations in the U.S. also highlight some of these opportunities to investigate ethnic differences, yet data are limited to a single U.S. cohort of Filipino women and scarce for other large Asian groups with few comparative investigations across Asian groups and between Asians and other ethnic groups in the U.S. MESA (Multi-Ethnic Study of Atherosclerosis) study reported a higher prevalence of coronary calcification Chinese Americans compared with African-American and Hispanic participants, and also explored the role of acculturation and socioeconomic position as predictors of coronary calcification (47,48). Small regional studies among South Asians in the U.S. have suggested a threefold higher prevalence of type 2 diabetes (49), and greater risk of metabolic syndrome at normal body weight when compared with non-Hispanic whites (50,51). The INTERHEART study had also found earlier onset of myocardial infarction in people in South Asia, compared with other countries, and much of this earlier incidence was explained by early onset of CVD risk factors (52). While South Asians appear to be at heightened type 2 diabetes and CVD risk despite relatively low BMI levels, Pacific Islanders in the U.S. (people from Hawaii, Guam, Samoa) are, in contrast, at high risk of obesity, diabetes, and CVD. From the limited data available, it appears that Asians consistently have higher diabetes prevalence than other populations, but CVD prevalence is variable. Furthermore, the association between body size and diabetes and/or CVD prevalence varies widely.

Investigating the link between CVD, diabetes and body size across Asian Americans, using a common protocol can be highly productive. A number of intriguing avenues for research are possible. Why do CVD and diabetes develop in some groups, like South Asians and Filipinos, at younger ages, and are their body size risk thresholds different? Why are there differences across Asian groups in the prevalence of diabetes and other cardiometabolic risk factors in persons with and without obesity? How do genes, maternal and early life exposures, differences in pathophysiology (e.g., adipocyte maturation), and cultural and acculturation factors explain these differences?

Both biological mechanisms and disease outcomes (mortality, morbidity, quality of life) need to be studied in the context of sociocultural and migration factors, lifestyle, and traditional practices. Limited data on subclinical markers of CVD in Asians have raised a number of questions. Well-designed population studies using minimum common protocols plus culturally specific questions may also permit development of customized risk scoring algorithms. Other unique opportunities include investigating the connections between maternal and early childhood undernutrition, low birth weight (51), later caloric excess, and cardiometabolic diseases in adulthood (53). Asian women are reported to have a 2- to 3-fold higher risk of gestational diabetes compared with Caucasian women (54), and the combination of high incidence of gestational diabetes, in utero nutritional imbalance, childhood obesity, and overnutrition (55) in adulthood in some Asian-American groups offers novel opportunities for research. A few studies have suggested the hitherto underexplored role of beta-cell dysfunction in Asian Americans; in Japanese Americans, visceral fat area and reduced insulin response were independent predictors of diabetes (27), and even a small increase in BMI produced beta-cell dysfunction disproportionate to that of changes in insulin sensitivity (56). Thus, investigating the role of early beta-cell dysfunction in the etiology of diabetes in Asian Americans may offer new and exciting insights. Other potentially interesting opportunities in studying Asian-American populations include the role of infectious agents, such as hepatitis B and C (57), hemoglobinopathies, and iron overload (58–60) in the etiology of diabetes.

Although there is some survey-based research that focuses on cardiovascular risk factors (e.g., exercise, diet) among the Asian-American population, this research tells us little about the underlying motivations and social and cultural influences on diet and exercise, information that is necessary for the development of interventions to reduce CVD risk in these populations. For example, research is needed on beliefs and perceptions that influence behaviors such as fatalism, and cultural barriers to participation in exercise such as modesty, language, women’s autonomy, and lack of childcare. There may also be economic barriers to use of recreation facilities and cultural practices related to diet.

Much more research is needed on dietary issues among the Asian Americans and Pacific Islanders. For example,
examining the social context of eating, shopping, and cooking; the social-cultural barriers to diet modification; household dynamics/influences on food choices, traditions, and modifications; and potential avenues for influencing traditionally high carbohydrate diet and eating patterns (61). A recent study of overweight South Asian Indian women showed that a lower carbohydrate diet can lead to weight loss, decreased insulin resistance, and reduction in several key CVD risk factors (62). There is a need for more in-depth qualitative and mixed methods studies on cardiovascular health issues among these populations: both survey data and in-depth studies should be considered to explore context, feasibility, and perceptions; outliers and motivators, perhaps contrasting Asians who do exercise and those who do not. Finally, longitudinal qualitative and culturally appropriate research should be encouraged (e.g., examine dietary patterns over time, examine sustainability of interventions).

Lessons from other countries, such as the United Kingdom, suggest that detailed studies of new immigrants are valuable (56,57). International studies of risk factors for myocardial infarction also suggest both broad commonalities in risk factors and interesting differences, especially between South Asian groups and others (49). The SHARE (Study of Health Assessment and Risk in South Asian, Chinese, and Aboriginal groups in Canada) group of investigators has also reported on the value of investigating rich differences across ethnic groups in CVD risk factors, atherosclerosis, and cardiovascular disease (63), and has also highlighted the challenges of defining obesity cut-points in multiethnic populations in Canada (64). These insights about obesity definitions have imminent relevance to the growing Asian-American populations in the U.S. (46).

There are several challenges to launching population studies of Asian Americans in the U.S. The numbers in each Asian group are still relatively small, and spread across the country. One potential option will be to identify geographical clusters within the country that have dense Asian populations. Using large managed care networks or previously identified populations may be an option, but this may under-represent lower socioeconomic groups or the uninsured. Even so, recruiting from across a whole range of socioeconomic distributions will be challenging. A pilot study in New York City used an innovative approach to reach out to the 40,000 taxi drivers in the city, where 40% of the taxi workforce is South Asian. In a literally curbside survey of 183 taxi drivers, 77% lacked health insurance, and 75% of 81 tested had random blood glucose levels >160 mg/dl (J. Changrani, personal communication, August 2008). New York City has embarked on a community-based survey of health of a representative sample of the city (65). Findings from this survey suggest that age-adjusted diabetes prevalence is 10.5% among whites, 12.3% among Hispanics, 14.5% among blacks, 16.1% among all Asians, and 27.5% among South Asians (65) (S. Rajpathak, personal communication, August 2008). However, the numbers in each Asian subgroup are too small to study the reasons for these differences. Nevertheless, these data reinforce the need for population-based studies across socioeconomic groups, using at least a common minimum protocol and adequate sample sizes for each major ethnic group. Ideally, at least 2 cities or communities should be studied for each ethnic group.

Conclusions

Asian Americans and Pacific Islanders are a fast-growing subpopulation in the U.S., with high rates of cardiometabolic disease and large implications for current and future public health and costs. The group brings the challenges of enormous genetic and cultural diversity. The pattern of increased visceral adiposity, type 2 diabetes, and CVD in the presence of normal or slightly elevated BMI is common among South Asians and Filipinos. Elevated risk of type 2 diabetes, hypertension, high LDL cholesterol, and low HDL cholesterol seem to be the most common traditional CVD risk factors among all Asian Americans, but appear at younger ages in South Asians. Obesity, on the other hand, seems to be prevalent mainly among Pacific Islanders and may be increasing among Japanese Americans. Given the heterogeneity in body weight, body size, and CVD risk, these populations afford a unique model to study the interaction and relationships between visceral adiposity and adipose tissue distribution and beta-cell function, insulin resistance, and atherosclerosis. These differences highlight the importance of conducting research among Asian subgroups separately as well as together. Asian-American populations, given the diversity and high proportion of immigrants, also offer opportunities to disentangle the roles of biology, socioeconomic factors, and acculturation stresses in CVD etiology. Lessons learned from studies of Asian-American groups may answer questions regarding cardiometabolic risk that will be of value not just to the health of this growing and diverse subpopulation in the U.S., but also to the general population of the country.

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REFERENCES


60. Lao TT, Ho LF. Alpha-thalassaemia trait and gestational diabetes mellitus in Hong Kong. Diabetologia 2001;44:966–71.


Key Words: cardiovascular disease • type 2 diabetes • Asian Americans • Pacific Islanders • ethnicity • disparity.

APPENDIX

For a full list of members of the Cardiovascular Disease in Asian and Pacific Islander Populations NHLBI Working Group, please see the online version of this article.