# Immigrant Asian Indians in the U.S.: A Population at Risk for Diabetes and Cardiovascular Disease

*Ranjita Misra*


## Abstract

Asian Indians are the third largest and fastest growing Asian subgroup in the U.S. and considered the model minority due to their high education and income level. Unlike other Asian immigrants, they are a more heterogeneous group with a genetic predisposition for diabetes and cardiovascular disease. Current national surveys are incapable of assessing risk factors and disease prevalence in specific Asian sub-populations because multiple ethnic groups are aggregated into the general category of "Asian and Pacific Islander," and because sample sizes of individual Asian sub-groups are small. This literature review highlights the need for large population-based studies to examine prevalence rate and changes in clinical and non-clinical risk factors for diabetes and cardiovascular disease among the growing immigrant Asian Indians in the United States. Implications for primary and secondary prevention and health promotion/health education are discussed.


## Introduction

While Asian Americans make up about 5% of the U.S.'s population (as of May 2005), they are one of the fastest growing racial/ethnic groups (in terms of percentage increase) in the U.S. According to the 2004 Census Bureau population estimate, there are 13.9 million Asian Americans living in the United States (OMH, 2006). In 2000, 12.9 million reported themselves as having either full or partial Asian heritage. The largest ethnic subgroups are Chinese (2.7 million), Filipinos (2.4 million), Asian Indians (1.9 million), Vietnamese (1.2 million), Koreans (1.2 million), and Japanese (1.1 million). Other sizable groups are Cambodians (206,000), Pakistanis (204,000), Laotians (198,000), Hmong (186,000), and Thais (150,000) (Asian-American Market Profile, 2004).

Type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) are important chronic diseases that have reached epidemic proportions in both industrialized and non-industrialized countries and are a significant public health problem. The prevalence of diabetes (worldwide) is projected at 300 million by 2025, an increase of 120% (King, Aubert, & Herman, 1998). The brunt of this increase (more than 80%) will be borne by the developing countries. Several factors have been implicated for this increase: population growth, genetic predisposition, high illiteracy rate, poverty, and sociological changes that impact lifestyle behaviors. Migrant Asian Indians (AIs) in the U.S. have an unusually high predisposition to develop both T2DM and CVD (King et al., 1998; McKeigue, Ferrie, Pierpoint, & Marmot, 1993). Asian Indians in India have higher prevalence of insulin resistance, a key pathophysiological factor, despite low rates of obesity and hence genetically pre-disposed to have diabetes (Table 1).

Prevalence of T2DM among immigrant AIs in the U.S. is lacking; reliable data from national surveys are limited due to small sample sizes or aggregation of ethnic data into a heterogeneous group of Asian Americans or Asian and Pacific Islanders. Hence the purposes of this paper are to (a) review the literature regarding studies on T2DM and CVD among AIs in the U.S. and (b) highlight the importance of health promotion and health education to prevent or reduce the early onset of the disease in this ethnic group. Lack of health promotion behaviors may contribute to an already increased risk for diabetes and requires culturally oriented health education for this high-risk population.

## Asian Indians - Demographics

Asian Indians are the third largest Asian subgroup in the U.S. and comprised 16.4% of the Asian American population (Census, 2000). The majority (71%) are 18 to 64 years old, and 77% are immigrants (Census, 2000). The growth rate of 106% from 1990 to 2000 is the highest among all Asian Americans (the second fastest growth was 83% for Vietnamese Americans)(Census, 2000). Despite this increase, current research on Asian American health does not adequately address their health needs.

Unlike other Asian immigrants in the U.S., AIs constitute a more heterogeneous group than immigrants from other Asian nations. They form distinct subgroups based on differences in language (14 major languages), provinces or states of origin (28 states), religions (five major religions), and race (at least four distinct racial types) (Gupta, Misra, Pais, Rastogi, & Gupta, 2006). This is evident from the numerous, diverse Asian Indian cultural and religious associations in U.S. cities with large AI populations. Distinctly different classes, social habits, cultural practices, diets, lifestyles, and optimistic or fatalistic orientations to life characterize these subgroups. First generation AIs tend to retain the distinct languages, culture, and religious practices of their subgroups, which inhibits the development of ethnic solidarity as seen among Chinese, Japanese, or Filipino immigrants (Kar, 1995).

Further distinction between Asian immigrants and AIs lies in their educational level. AIs are generally well-


Ranjita Misra, PhD, CHES, FMALRC; Associate Professor; School of Allied Medical Professions; College of Medicine; The Ohio State University, 453 W. Tenth Avenue, Columbus, OH 43210-1234; Telephone: 614-292-4507; Fax: 614-292-0210; E-mail: ranjita.misra@osumc.edu; Chapter: Alpha Pi

Table 1

*Insulin Resistance[a] in Asian Indians Living in India*

| Author & year | Study group | N | Geographic location | Measure of IR | Observations |
|---|---|---|---|---|---|
| Ramachandran et al., 1998 | Men & women[b] | 953 | Chennai, South India | FI and post-glucose 120 min insulin levels | ~55% age-adjusted prevalence of high 2-h insulin levels |
| Snehalatha et al., 2000 | Non-diabetic subjects | 654 | Chennai, South India | OGTT, HOMA-IR | High FI: F ~54%, M 37%; ↑ 2-h insulin: F ~72%, M 51%; IR: M 11%, F 13.6% |
| Mohan et al, 2001 | Middle & low-income groups | 479<br>783 | Chennai, South India | FI levels | High FI levels in middle income group |
| Snehalatha et al., 2001 | Non-diabetic subjects[c]<br>NGT<br>IGT | <br><br>48<br>51 | Chennai, South India | HOMA-IR | High HOMA-IR in IGT Vs NGT (7.9 ± 4.2 vs. 6.07 ± 3.76) |
| Misra et al., 2002 | Women residing in urban slums | 80 | New Delhi, North India | HOMA-IR | High HOMA-IR in ~23%; High FI levels in 26% |
| Deepa et al, 2003 | Subjects from upper & low SES | 1,070 | Chennai, South India | HOMA-IR | IR ~19% in high SES; ~7% in low SES |
| Mishra et al., 2004 | Post-pubertal school children | 377 | New Delhi, North India | FI levels, HOMA-IR | FI; M, 18.7 μU/L, F, 23 μU/L[d]<br>↑ FI; M, 21.8%, F, 35.8% |

*Note.* FI = fasting plasma insulin; HOMA-IR = homeostasis model assessment of insulin resistance. OGTT = oral glucose tolerance test.

[a] Insulin resistance (IR) defined by insulin levels or its ratio with fasting blood glucose. [b] Aged ≥ 40 years. [c] Subjects with normal glucose tolerance (NGT) and impaired glucose tolerance (IGT) matched for body mass index (BMI) and waist-hip-ratio (W-HR). [d] Highest quartile in the study group.

educated with the highest annual household income among all Asian American immigrants. Hence, they are perceived to achieve a much greater degree of success in the U.S., and are stereotyped as the model minority (Misra, Patel, Davies, & Russo, 2000). According to the 2000 Census, the median household income is $60,093 compared to $41,110 for non-Hispanic Whites (Census, 2000; Rao, 2003) and 67% of foreign-born AIs have a college education compared to 21% for Caucasians (Census, 2000). Hence, AIs are perceived as having good access to health care (Misra et. al., 2000). However, they are not always a model minority for health. Their level of English fluency, diet, and lifestyles vary. There are marked variations in educational attainment, income, English fluency, diet, and lifestyle among AIs. Recent immigrant cohorts comprise both highly educated professionals as well as individuals who lack education and job skills. The latter are mostly family members of earlier immigrants (Diwan, 2008). All of these factors affect the health of AIs, especially when it comes to accessing health care, risk for T2DM and CVD, and unhealthy habits such as smoking.

### Prevalence of Diabetes and Cardiovascular Disease

Although the burden of diabetes incidence (new cases) and prevalence (all cases) have been increasing for all racial and ethnic groups in the U.S., AIs have higher rates of diabetes (generally over 10%) and diabetes-related morbidity and mortality compared to whites and other ethnic groups (Enas et al., 1996; Yusuf, Reddy, Ounpuu, & Anand, 2001). Insulin resistance is very high among migrant AIs in the U.S. (Table 2). Despite limited population-based studies in the U.S., diabetes prevalence among AIs in the U.S. is two to three times higher than the general U.S. population (Mohanty, Woolhandler, Himmelstein, & Bor, 2005; Venkataraman, Nanda, Baweja, Parikh, & Bhatia, 2004) (Table 3). However,

Table 2

*Insulin Resistance[a] in Asian Indians Living in US/Westernized Countries*

| Author & year | Study group | Sample size | Geographic location | Measure of IR | Summary of findings |
|---|---|---|---|---|---|
| Chandalia et al. 1999 | Men | 44 | USA | OGTT | Results show that Asian Indian men are more insulin resistant than Caucasian men independently of generalized or truncal adiposity. |
| Banerji et al. 1999 | Men | 20 | USA | OGTT | Insulin action was inversely correlated with visceral adipose tissue, not total or abdominal sc adipose tissue. |
| Chambers et al. 2001 | Men | 1,025 | UK | Insulin resistance score was calculated as the sum of 2 scores for systolic blood pressure, fasting glucose, waist-hip girth fat 10, HDL cholesterol, and fasting triglycerides. | CPR concentration was 17% higher in Indian Asians than European whites. |
| Dhawan et al. 1994 | Men | 200 | Manchester, UK; New Delhi, India | Fasting insulin & HDL Concentrations were independent predictors of coronary artery disease in white men, where as in British Asians the waist to hip ratio was the strongest independent predictor. | Asians in UK and in India had higher prevalence of diabetes & impaired glucose tolerance than white British men. |
| Abate et al. 2004 | Men | 140 | USA | OGTT | Plasma concentrations of adipose tissue metabolites leptin & NEFAS are higher & that of adiponectin is lower in IR Asian Indians compared with more insulin-sensitive Caucasians. |
| Laws et al. 1994 | Men & Women | 22 | USA | OGTT | Both sexes were consistent w/ resistance to insulin suppression of free fatty acid levels in Asian Indians. They also had higher fasting plasma triglyceride & lower HDL cholesterol concentrations than men/women of European ancestry. |

*Note*. OGTT= oral glucose tolerance test; HDL = high density lipoprotein; NEFAs = nonesterified fatty acids; IR = insulin resistence; CPR = C-peptide immunoreactivity.

the risk factors for developing T2DM have not been systematically assessed in a population-based perspective and random studies among migrant AIs, nor have changes in these risk factors as they acculturate to western society received attention. Mohanty and her colleagues (2005) analyzed the National Health Interview Survey (NHIS) data from 1997-2000 for prevalence of diabetes, obesity, coronary heart disease, and hypertension among AIs and reported that AIs had significantly higher odds of borderline or overt diabetes as compared to non-Hispanic whites. Small sample size did not allow subgroup analysis by gender or age. Further, NHIS is conducted in English or Spanish thus limiting AIs with limited English proficiency, thereby possibly underestimating disease prevalence. Venkataraman and his colleagues (2004) surveyed a convenience sample of 1,046 AIs in Atlanta during religious congregations and reported an overall prevalence of diabetes at 18.3%, higher than all other racial groups in the U.S. Prevalence of diabetes was ascertained by the number of individuals with previously diagnosed T2DM and from undiagnosed cased (fasting blood sugar ≥ 126 mg/dl).

Cardiovascular disease refers to a class of diseases that involve the heart or blood vessels. It is a macro vascular complication of diabetes and affects migrant AIs disproportionately. Their age-standardized CVD rates and related morbidity and mortality are much higher than those of Caucasians and other ethnic groups (Yusuf et al., 2001). Asian Indians manifest a dyslipidemic pattern that includes hypertriglyceridemia, low levels of high-density lipoprotein cholesterol (HDL-C), and high levels of small, dense low density lipoprotein (LDL) that is proatherogenic and characteristic of insulin resistance (McKeigue et al., 1993; Misra & Vikram, 2004). In addition, studies have reported that AIs have a higher procoagulant tendency (i.e., increase the risk for CVD), high levels of homocysteine (hyperhomocysteinemia), greater endothelial dysfunction (i.e., inability to dilation or constriction of the blood vessels) and increased sub-clinical inflammation (deterioration in the health of the skin) than Caucasians (Chambers et al., 2001; Forouhi, Sattar, & McKeigue, 2001; Kain, Catto, & Grant, 2002; Misra, 2003). Many of these abnormalities commonly cluster together in the form of a metabolic syndrome (Misra et al., 2002). However, the mechanisms underlying insulin resistance have not been clearly defined for AIs. For example, the contributions of body fat distribution (visceral compared to subcutaneous fat) to insulin resistance, T2DM and CVD risk factors have received only marginal attention up to now (Ramachandran et al., 2004). Some of these factors are discussed in the following section.

## Insulin Resistance

The pancreas of a person with type 2 diabetes makes insulin, but the body does not use insulin properly—this is called *insulin resistance*. Although insulin resistance tends to run in families, excess weight and lack of physical activity also contribute since they reduce muscles' ability to use insulin. Many people with insulin resistance and high blood glucose have high central obesity (excess weight around the waist), cholesterol, triglycerides and blood pressure, all conditions that put the heart at risk. This combination of problems is referred to as metabolic syndrome (MetS), or insulin resistance syndrome (formerly called Syndrome X). Metabolic syndrome is defined as a clustering of risk factors; presence of three or more of the following - abdominal obesity, low levels of HDL, high levels of serum triglyceride, high blood pressure, and high blood glucose levels - meets the diagnosis of MetS. Presence of insulin resistance and metabolic syndrome indicate high risk for diabetes and cardiovascular disease among individuals.

Reported prevalence of insulin resistance in migrant AIs ranges from 10-50% (McKeigue et al., 1993; Simmons & Powell, 1993; Snehalatha, Satyavani, Sivasankari, Vijay, & Ramachandran, 1999). The rates are consistently higher than in other Asian ethnic groups and Caucasians (Simmons & Powell, 1993; Whincup et al., 2002). Insulin resistance in AIs manifests early in life, even at birth (Yajnik et al., 2002) or during childhood (Dickinson, Colagiuri, Faramus, Petocz, & Brand-Miller, 2002). Furthermore, high insulin levels (hyperinsulinemia) and insulin resistance, prevalent in even 'non-obese' AI adults is associated with abnormal lipids levels and is believed to be a critical factor for contributing to the high prevalence of T2DM and CVD in this ethnic group (Misra, 2003). One study on US AI physicians and their relatives showed a higher prevalence of T2DM, high triglycerides and obesity, and lower levels of HDL-C compared to Caucasians (Enas et al., 1996). However, more studies are necessary for a careful investigation of the mechanisms and determinants of insulin resistance among migrant AIs in the U.S. Research on migrant AIs in the U.S. is limited, even with the utilization of either hospital-based or convenience samples.

## Risk Factors for Diabetes and Cardiovascular Disease

### *Clinical Risk Factors*

Many studies suggest that "healthy" adult AIs, especially females, have abnormal body composition characterized by an excessive percentage of total body fat and abdominal fat (detailed below). This body composition may partially explain the occurrence of some of the risk factors (Deurenberg-Yap, Schmidt, van Staveren, & Deurenberg, 2000; Yajnik et al., 2002). Other abnormalities include higher visceral and subcutaneous truncal fat (Banerji, Faridi, Atluri, Chaiken, & Lebovitz, 1999; Chandalia, Abate, Garg, Stray-Gundersen, & Grundy, 1999; Raji, Seely, Arky, & Simonson, 2001). Further, AIs (both males and females) have lower waist circumferences but comparable ratios of waist-to-hip circumference compared to Caucasians. Such abnormalities may contribute to the development of insulin resistance and dyslipidemia as noted earlier. Studies show a 'westernized' lifestyle including changes in dietary habits and physical inactivity (elaborated in a later section), knowledge of and residence in a westernized country contribute to increase in

Table 3

*Prevalence of Diabetes in Asian Indians Living in US/Westernized Countries*

| Author & year | Study group | Sample size | Geographic location | Measure of diabetes prevalence type of setting | Summary of findings |
|---|---|---|---|---|---|
| Ramachandran et al., 2001. | Men and women stratified sandom sample | 5,288 men<br>5,928 women | Six major cities in India | National Survey by age | Diabetes and impaired glucose tolerance - 12.1% and 14.0%; <40 years - higher IGT; diabetes were high in urban India. |
| Ramaiya & Albert, 1990. | NIDDM in Migrant Indians | Men and women | Indian subcontinent | Prevalence of diabetes | NIDDM rates have either been underestimated or are raising. |
| Misra et al., 2001 | Men and women urban slum population | 170 males<br>362 females | City in northern India | Prevalence survey of atherosclerosis risk factors | Obesity, dislypidemia, diabetes mellitus increase in body fat, obesity in middle age, needs immediate attention in terms of prevention and health education. Diabetes mellitus 11.2% of males and 9.9% of females. |
| Zimmet et al., 1983 | Malaysian and Indian population | Men and women (biracial) | Fiji Islands | Age standardized comparison of NIDDM & IGT | Physical factors such as obesity, diet, and stress contribute to differences. Genetic factors are important in producing diabetes in Indians. |
| Mohanty et al., 2005 | Men and women | 87,846 Non-Hispanic Whites<br>555 Asian Indians | Outside of US | Cross-sectional study using data from NHIS for 1997, 1998, 1999, and 2000 | Asian Indians in U.S. have higher odds of being diabetic despite lower rates of obesity. |
| Ramachandran et al., 1992 | Men and women | 900 urban<br>1,038 rural | Urban and rural areas of southern India | Prevalence of NIDDM and IGT | NIDDM increased with age. Urban-rural differences were significant for NIDDM but not for IGT. High NIDDM in urban southern Indian Population. |
| McNeely et al., 2004. | Asian American men and women ≥30 years | 3,071 Asians;<br>12,561 Blacks;<br>12,153 Hispanic;<br>2,299 Native American;<br>626 Pacific Islands,<br>129,116 Non-White Hispanics | All 50 states, Guam, Puerto Rico, Virgin Islands | National Survey type 2 diabetes | Similar proportions of Asian and non-Hispanic white Americans have diabetes. When accounting for lower BMI of Asians, adjusted prevalence of diabetes is 60% higher in Asian Americans. |
| Venkataraman et al., 2004 | Asian Indian men and women > 20 years | 1,046 Asian Indians immigrants | In and around Atlanta metro area of Georgia | Community-based survey prevalence of diabetes mellitus | Overall prevalence of diabetes mellitus 18.3%. Prevalence is higher in Asian Indians than whites, blacks, and Hispanics living in U.S. |

*Note.* NIDDM = non insulin dependent diabetes mellitus; IGT = impaired glucose tolerance; BMI = body mass index; NHIS = National Health Interview Survey.

overall and regional fat mass distribution that have not been investigated in U.S. AIs.

The average body mass index (BMI) of AIs and South Asians (individuals from India, Pakistan, Bangladesh and Sri Lanka) is lower than average BMI of Whites, Mexican Americans and African Americans. However, male and female AIs have higher BMI as they become affluent and urbanized. Furthermore, AIs seem to have a genetic phenotype of low BMI and high central adiposity compared to Caucasians and African Americans, also called the Yudkin-Yajnik paradox (Misra & Vikram, 2004; Yajnik et al., 2002). A high prevalence of abdominal obesity is characteristic of South Asians (McKeigue et al., 1993; Misra & Vikram, 2004). Although the average waist circumference in South Asians appears to be lower than in Caucasians, abdominal obesity is significantly greater among the former group, and much higher among females than males (Banerji et al., 1999; Raji et al., 2001) .

A distinctive anthropomorphic feature in South Asians is thick subcutaneous fat (Banerji et al., 1999; Chandalia et al., 1999). Higher insulin resistance in AI men compared to BMI-matched Caucasians was explained by higher truncal skinfold thickness in the former (Chandalia et al., 1999). A significant association of truncal skinfold thickness with fasting hyperinsulinemia in children and adolescents also has been noted (Bhardwaj et al., 2008). Interestingly, thicker subscapular subcutaneous fat was present at birth in AIs compared to British neonates, and was associated with higher insulin levels (Yajnik et al., 2002). Hence thick truncal subcutaneous tissue may be an important correlate of insulin resistance in AIs. Obesity parameters are established risk factors for type 2 diabetes and prevention/intervention programs can successfully reduce or help prevent or delay the precipitation of this disease among AIs.

***Blood Pressure.***

Hypertension is a strong predictor of CVD mortality. AIs in the U.S. do not show an elevated risk for hypertension and coronary heart disease (Mohanty et al., 2005). Hypertension is not a consistent component of insulin resistance; however, it may be exacerbated by high salt intake, stress, smoking and weight gain – all factors prevalent in migrant populations. There are no reported population-based studies of the prevalence of hypertension in migrant AIs in the U.S.

***Blood Lipids and Lipoproteins.***

The lipid profile in AIs is characterized by high triglyceride levels, low levels of HDL (or the good cholesterol) and high levels of small, dense LDL (McKeigue et al., 1993; Misra & Vikram, 2004). These characteristic abnormalities commonly accompany insulin resistance and T2DM in AIs (Misra & Vikram, 2004). Low levels of HDL and high serum triglycerides are considered proatherogenic and conducive to the development of CVD. High intra-abdominal fat and truncal subcutaneous fat, also characteristically seen in AIs, increase the systemic flux of free fatty acids and result in dyslipidemia. LDL levels among AIs in the United States are similar to whites(Enas, Chacko, Pazhoor, Chennikkara, & Devarapalli, 2007). In general, AI women are more likely to be diabetic and/or hypertensive, and have higher total cholesterol, low-density lipoprotein, and triglyceride levels than their male peers (Shammas et al., 2006). However, clinical practice guidelines issued by the National Cholesterol Education Program (NCEP) in 2001 are based on evidence from controlled trials in Caucasians; whether these guidelines are also applicable to other ethnic groups and both genders is unknown.

***C-Reactive Protein.***

C-reactive protein (CRP) is a marker of subclinical inflammation and high levels have been shown to predict heart disease, T2DM, and metabolic syndrome (Ridker, Rifai, Rose, Buring, & Cook, 2002). CRP levels in adult migrant South Asians are higher than in Caucasians (Chambers et al., 2001; Forouhi et al., 2001) and may be responsible for ~14% increase in CVD risk compared to Caucasians. The high CRP levels in South Asians could be explained by excess abdominal adiposity. Whereas CRP levels in migrant South Asians were correlated with insulin resistance (Chambers et al., 2001), investigations of young AIs residing in India have failed to show strong relationships (Vikram, Misra, Pandey, Dwivedi, & Luthra, 2004). A plausible reason is that CRP levels in the young population are largely determined by infections related to poor socioeconomic and unhygienic environmental conditions, which in turn may lead to transiently or persistently elevated CRP levels unrelated to abdominal obesity (Misra & Vikram, 2004). Mohan et al. (2005) have shown that CRP levels do not appear to mediate the relationship between body fat and CVD among AIs residing in India.

***Homocysteine and Lipoprotein(a).***

Studies have shown that AIs have higher homocysteine levels than whites (Chambers et al., 2001; Vikram et al., 2004), in association with low vitamin B12 and folic acid levels. Similarly, Lipoprotein a [also called Lp(a)] is a protein in the blood and higher levels indicate CVD risk. Higher levels of Lp (a) have been found in AIs, but more recent data are inconsistent in this regard (Tavridou, Unwin, Bhopal, & Laker, 2003). Hence patient education for this ethnic group should emphasize a proactive assessment of these risk factors for those with personal or family history of T2DM or CVD and educate individuals on understanding these novel risk factors.

***Non-Clinical Risk Factors***

Clinically measurable parameters do not account for all factors contributing to the development of T2DM and CVD. Many non-clinical factors may contribute to the early onset of T2DM and CVD (Misra et al., 2000). The focus has been on psychosocial and behavioral domains as opposed to environmental and cultural domains of influence, as well as possibly unique cultural and environmental interactions (e.g., acculturation and utilization of health care, and changes in diet and physical activity). The ecological model stipulates an interplay of cultural and lifestyle/environmental factors in the onset of metabolic syndrome, diabetes and CVD (Bobak et al., 1999). Social Cognitive Theory has been used to predict adherence to certain diabetes-related outcomes, such as diet adherence, exercise, and self-monitoring of glucose (Chapman-Novakofski & Karduck, 2005). Additional components include beliefs and self-efficacy which have been linked to adherence to diet, physical activity, and improved glycemic control. Important cultural factors include ethnic customs and cultural and health beliefs that influence dietary intake and physical activity. Environmental factors that impact the incidence and complications of diabetes and CVD include socioeconomic status and health care access and utilization. An individual's degree of acculturation has an influence on dietary intake and utilization of health care (Sundquist, Winkleby, & Pudaric, 2001). Socio-economic status plays a decisive role in an individual's access to open spaces, sports equipment, and health clubs. This fact is supported by research indicating that low-income populations across all age groups suffer from higher rates of mortality and morbidity due to diabetes and CVD (Sundquist et al., 2001).

#### *Acculturation and Lifestyle.*

Immigrants who have lived in the U.S. for longer periods of time and with higher degrees of acculturation may have different lifestyles than those who report fewer years of residence or lesser degrees of acculturation (Kalra, Srinivasan, Ivey, & Greenlund, 2004). Food habits are changing among AIs in the U.S., particularly among adolescents, due to the attractive and aggressive advertisement campaigns of the fast food industry, low cost, and peer pressure to "fit in"(Perry, McGuire, Neumark-Sztainer, & Story, 2002). Changes include consuming fast food and increasing dietary fat, calories and salt. Each of these practices results in a less than adequate intake of foods of appropriate nutritional value (Lv & Cason, 2004). Activity profiles of AIs also vary based on socio-economic status and years of residence in the U.S. While some have become more aware of the benefits of physical activity and exercise (as defined by Surgeon General's report i.e., 5 times a week for at least 30 minutes), physical inactivity is still more common among AI migrants than other ethnic groups (Mohanty et al., 2005). Obesity also is linked to diet and lack of physical activity.

Among lifestyle factors, physical activity and tobacco use are important determinants of an adverse metabolic profile (Bhardwaj, 2008). Unfortunately, there are no well-designed cohort studies to assess the influence of lifestyle factors in immigrant AIs in the U.S. The genetic predisposition of AIs coupled with their physical inactivity and westernized diet can lead to early onset of chronic diseases (Misra, Endemann, & Ayer, 2006) .

### Health Promotion and Health Education

Although diabetes is a chronic debilitating disease, one can prevent or delay the early onset of T2DM and its complications through primary and secondary prevention measures. There is an association between increased urbanization or westernization and the rapid epidemiological rise in the disease among AIs (Mohanty et al., 2005). The sudden changes in the traditional lifestyles and dietary patterns are perhaps the main culprits in the steep rise of diabetes among this immigrant and high-risk ethnic group. Furthermore, physical inactivity and consumption of diets rich in fat, sugar and calories are potential culprits. Hence, a health-promoting lifestyle needs to be emphasized for this group (Blacconiere & Oleckno, 1999). Poor diet and physical inactivity are modifiable behaviors that can reduce obesity, T2DM and CVD among AIs in the U.S. Asian Indians are less active than Caucasians and less likely to meet the Surgeon General's recommendation for physical activity. Sedentary lifestyle is a critical factor for the development of insulin resistance and high risk for chronic disease. Hence, culturally appropriate physical activity programs are recommended. For example, use of new kind of "calorie-burning" cultural dance experience that combines Indian culture with fitness such as the "bhangra" dancercise can provide AIs with a vigorous and effective workout utilizing moves from traditional Indian folk dance with cardiovascular routine and is suitable for people of all ages and fitness levels. Physical inactivity is more pronounced among women and the elderly and thus age- and gender-specific programs to promote activity levels are recommended.

The benefit of health promotion and health education lies in reduction in high health care costs associated with T2DM morbidity and mortality as well as disease progression (Shah, 2005). Although the relative importance of genetic heritage, diet, exercise, socioeconomic status, culture, language, and access to health care in the prevalence, incidence, and mortality of diabetes is not clear, prevention of T2DM has been shown through intense lifestyle changes (diet and physical activity), more than the use of metformin (drug intervention), in the Diabetes Prevention Program (DPP) trial (Palmer, 2004). Recent research strongly supports targeting individuals at-risk or with pre-diabetes through therapeutic lifestyle change (Palmer, 2004). Lifestyle changes also are relevant to individuals with T2DM and affects their glycemic control through effective self-management behaviors that includes diet, physical activity, self monitoring of blood glucose, and medication (Palmer, 2004).

### Role of Health Educators for Culturally Appropriate Prevention Programs

Health educators are uniquely positioned to address the needs of immigrant AIs in a culturally appropriate manner.

High risk individuals i.e., those in the pre-diabetes stage and individuals with diabetes should be targeted with clinic- and community-based prevention/lifestyle intervention programs in order to reduce diabetes before its onset or prevent complications. Pharmacological intervention may be combined with behavior modification, if necessary. In order to identify these high-risk individuals, information on obesity, lack of exercise, childhood birth weight, and family history can be used to impress upon [these] individuals the seriousness of the risk (Palmer, 2004). Screening tools (e.g., the Archimedes model) are also available (based on age, waist, family history, etc for calculating the risk score) on the American Diabetes Association website (www.diabetes.org/diabetesphd).

Practical guidelines for AIs as well as health professionals working with Asian Indian clients needs to be presented for greater effectiveness. These include an emphasis on nutritional concerns and problems that stem from dietary changes among immigrant AIs such as altered vegetarian status, meal patterns, increased usage of fast and convenience foods, and the inclusion of other ethnic and American foods as substitutes for traditional foods. Hence, health educators can educate AIs regarding dietary guidelines for a healthy diet i.e., eating a wide variety of foods, balancing diet with physical activity, eating high fiber foods, such as whole grains, millets, fruits, vegetables and greens, use less added sugar and salt, and avoid foods high in saturated fat and cholesterol. Nutrition also is an important part of the treatment regimen for individuals with diabetes. Hence nutritional therapy for AIs should focus on maintaining optimal nutrition, education regarding portion sizes, modifying recipes for improved nutritional values, controlling blood glucose and preventing and treating related complications. Carbohydrate counting and exchange lists, low carbohydrate diets (e.g., avoid sugar and starches, avoiding soft drinks, etc) as well the use of traditional complex carbohydrates such as brown rice and chapatti instead of white rice or bread will help increase fiber intake. Protein intake should concentrate on lean meats, poultry, fish and the use of beans and cereal lentil combinations. Stepwise modification in diet is recommended if individuals are unable or unwilling to made drastic changes. For example, white rice can be substituted with white rice and beans and legumes, vegetables and mixed cereals progressively in steps. Reading nutrition labels using available literature such as the "Asian Indian cuisine and the management of diabetes" at www.aapiusa.org/care/healthandnutrition.htm are encouraged.

Most AIs are well-educated and proficient in English. Hence, use of successful diabetes education programs can improve the knowledge of diabetes incidence and heightened risk factors with westernized lifestyle. Furthermore, barriers to use of prevention and screening behaviors can address why AIs with access to health care do not use preventive health services. Health educators can emphasize the use of wellness check-ups and screenings to detect diseases early thereby increasing opportunities for interventions and treatment to prevent progression of the disease and complications as well as lowering the morbidity and mortality associated with diabetes. Programs for AIs should emphasize weight maintenance using the Asian criteria for overweight and obesity (BMI $\geq$ 23) and a focus on energy balance and calories to maintain a healthy weight. Use of faith-based organizations, such as temples, and health fairs are excellent avenues for this ethnic group to advocate lifestyle intervention and address acculturative changes. Gender specific issues also are important since sedentary lifestyle is greater among females and lack of use of health services is greater among male AIs (Misra et al., 2000).

Although most AIs are well-educated and generally of high socioeconomic status, disease specific knowledge may be lacking given their high rates of diabetes, heart disease, and sedentary lifestyle. Health education can increase knowledge of diabetes and other chronic diseases. Not all AIs, however, are proficient in English. Recent immigrants (who are family members) may have problems communicating with health professionals due to language and cultural differences. Since there is limited literature about health education for AIs, literature on diabetes health education for minorities (e.g., Mexican Americans) may be useful. Cultural assessment prior to instituting health education programs and the development of innovative and culturally acceptable health education methods such as storytelling traditions are important. We also have much to learn from health education techniques currently being used in India, such as raising awareness of diabetes in the community, diabetes education camps (Viswanathan, 1986) and the use of trained community members (lay leaders) to give simple health education advice to their peers.

## Conclusion

AIs in the U.S, a growing and high-risk ethnic group, are inappropriately considered the "model minority," a myth that is highlighted in this paper. With national studies are incapable of assessing prevalence and risk factors for Asian subgroups, national (epidemiological) studies on AIs can help quantify the incidence/prevalence rates and understand the epidemiology and modifiable/behavioral risk factors of T2DM and CVD in this group. Genetic predisposition to diabetes and heart disease is confounded by acculturative changes that occur with westernization and increase the incidence and prevalence rates. Culturally appropriate dietary education and physical activity programs are necessary to reduce premature morbidity and mortality.

Health education and health promotion can emphasize the preventive strategies and benefits of primary and secondary education to improve wellness checkups and screening for early diagnosis. Dietary changes are also necessary to avoid high carbohydrate foods and nutrition labels on ethnic foods need to be made available and encouraged by restaurants and ethnic food stores.

## References


Asian-American Market Profile. (2004). International paper. *Magazine Publishers of America.* Retrieved December 8, 2008 from http://www.magazine.org

Banerji, M. A., Faridi, N., Atluri, R., Chaiken, R. L., & Lebovitz, H. E. (1999). Body composition, visceral fat, leptin, and insulin resistance in Asian Indian men. *Journal of Clinical Endocrinology and Metabolism, 84*(1), 137-144.

Bhardwaj, S., Misra, A., Khurana, L., Gulati, S., Shah, P., & Vikram, N. K. (2008). Childhood obesity in Asian Indians: a burgeoning cause of insulin resistance, diabetes and sub-clinical inflammation. *Asia Pacific Journal of Clinical Nutrition, 17*(Suppl. 1), 172-175.

Blacconiere, M. J., & Oleckno, W. A. (1999). Health-promoting behaviours in public health: Testing the health promotion model. *Journal of the Royal Society of Health, 119*(1), 11-16.

Bobak, M., Hense, H. W., Kark, J., Kuch, B., Vojtisek, P., Sinnreich, R., et al. (1999). An ecological study of determinants of coronary heart disease rates: A comparison of Czech, Bavarian and Israeli men. *International Journal of Epidemiology, 28*(3), 437-444.

Census, U. S. (2000). *Statistical Abstract of the United States.* Washington, D.C.

Chambers, J. C., Eda, S., Bassett, P., Karim, Y., Thompson, S. G., Gallimore, J. R., et al. (2001). C-reactive protein, insulin resistance, central obesity, and coronary heart disease risk in Indian Asians from the United Kingdom compared with European whites. *Circulation, 104*(2), 145-150.

Chandalia, M., Abate, N., Garg, A., Stray-Gundersen, J., & Grundy, S. M. (1999). Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. *Journal of Clinical Endocrinology and Metabolism, 84*(7), 2329-2335.

Chapman-Novakofski, K., & Karduck, J. (2005). Improvement in knowledge, social cognitive theory variables, and movement through stages of change after a community-based diabetes education program. *Journal of the American Dietetic Association, 105*(10), 1613-1616.

Deurenberg-Yap, M., Schmidt, G., van Staveren, W. A., & Deurenberg, P. (2000). The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. *International Journal of Obesity Related Metabolic Disorder, 24*(8), 1011-1017.

Dickinson, S., Colagiuri, S., Faramus, E., Petocz, P., & Brand-Miller, J. C. (2002). Postprandial hyperglycemia and insulin sensitivity differ among lean young adults of different ethnicities. *The Journal of Nutrition, 132*(9), 2574-2579.

Diwan, S. (2008). Limited English proficiency, social network characteristics, and depressive symptoms among older immigrants. *Journal of Gerontology. Series B: Psychological Sciences and Social Sciences, 63*(3), S184-191.

Enas, E. A., Chacko, V., Pazhoor, S. G., Chennikkara, H., & Devarapalli, H. P. (2007). Dyslipidemia in South Asian patients. *Current Atherosclerosis Report, 9*(5), 367-374.

Enas, E. A., Garg, A., Davidson, M. A., Nair, V. M., Huet, B. A., & Yusuf, S. (1996). Coronary heart disease and its risk factors in first-generation immigrant Asian Indians to the United States of America. *Indian Heart Journal, 48*(4), 343-353.

Forouhi, N. G., Sattar, N., & McKeigue, P. M. (2001). Relation of C-reactive protein to body fat distribution and features of the metabolic syndrome in Europeans and South Asians. *International Journal of Obesity Related Metabolic Disorder, 25*(9), 1327-1331.

Gupta, R, Misra, A., Pais, P., Rastogi, P., & Gupta, V. P. (2006). Correlation of regional cardiovascular disease mortality in India with lifestyle and nutritional factors. *International Journal of Cardiology, 108*(3), 291-300).

Kalra, P., Srinivasan, S., Ivey, S., & Greenlund, K. (2004). Knowledge and practice: The risk of cardiovascular disease among Asian Indians. Results from focus groups conducted in Asian Indian communities in Northern California. *Ethnicity and Disease, 14*(4), 497-504.

Kar S., C. K., Jimenez A, Gupta S. (1995). Invisible Americans: An exploration of Indo-American quality of life. *Amerasia Journal, 21*, 25-52.

King, H., Aubert, R. E., & Herman, W. H. (1998). Global burden of diabetes, 1995-2025: Prevalence, numerical estimates, and projections. *Diabetes Care, 21*(9), 1414-1431.

Lv, N., & Cason, K. L. (2004). Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *Journal of the American Dietetic Association, 104*(5), 771-778.

McKeigue, P. M., Ferrie, J. E., Pierpoint, T., & Marmot, M. G. (1993). Association of early-onset coronary heart disease in South Asian men with glucose intolerance and hyperinsulinemia. *Circulation, 87*(1), 152-161.

Misra, A. (2003). Body composition and the metabolic syndrome in Asian Indians: A saga of multiple adversities. *National Medical Jouranl of India, 16*(1), 3-7.

Misra, A., & Vikram, N. K. (2004). Insulin resistance syndrome (metabolic syndrome) and obesity in Asian Indians: Evidence and implications. *Nutrition, 20*(5), 482-491.

Misra, K. B., Endemann, S. W., & Ayer, M. (2006). Measures of obesity and metabolic syndrome in Indian Americans in northern California. *Ethnicity and Disease, 16*(2), 331-337.

Misra, R., Patel, T. G., Davies, D., & Russo, T. (2000). Health promotion behaviors of Gujurati Asian Indian immigrants in the United States. *Journal of Immigrant Health, 2*(4), 223-230.

Mohan, V., Deepa, R., Velmurugan, K., & Premalatha, G. (2005). Association of C-reactive protein with body fat, diabetes and coronary artery disease in Asian Indians: The Chennai Urban Rural Epidemiology Study (CURES-6). *Diabetes and Medicine, 22*(7), 863-870.

Mohanty, S. A., Woolhandler, S., Himmelstein, D. U., & Bor, D. H. (2005). Diabetes and cardiovascular disease among asian indians in the United States. *Journal of General Internal Medicine, 20*(5), 474-478.

OMH. (2006). *Office of Minority Health: Asian American profile*. Retrieved August 1, 2008, from http://www.omhrc.gov/templates/browse.aspx?lvl=2&lvlID=53

Palmer, A. J., Roze, S., Valentine, W. J., Spinas, G. A., Shaw, J. E., & Zimmet, P. Z. (2004). Intensive lifestyle changes or metformin in patients with impaired glucose tolerance: Modeling the long-term health economic implications of the diabetes prevention program in Australia, France, Germany, Switzerland, and the United Kingdom. *International Clinical Therapeutics, 26*(2), 304-321.

Raji, A., Seely, E. W., Arky, R. A., & Simonson, D. C. (2001). Body fat distribution and insulin resistance in healthy Asian Indians and Caucasians. *Journal of Clinical Endocrinology and Metabolism, 86*(11), 5366-5371.

Ramachandran, A., Snehalatha, C., Baskar, A. D., Mary, S., Kumar, C. K., Selvam, S. (2004). Temporal changes in prevalence of diabetes and impaired glucose tolerance associated with lifestyle transition occurring in the rural population in India. *Diabetologia, 47*(5), 860-865.

Rao, P. V. (2002). Dietary patterns and glucose intolerance among rural Indian populations. *Journal of Indian Medical Association, 100*(3), 137-140.

Rao, K. V. (2003). Asian Indians. In E.Y. P. Lai & D. Arguelles (Eds.), *The new face of Asian Pacific America: Numbers, diversity, and change in the 21st century* (pp.51-56). Berkley, CA: Consolidated Printers, Inc.

Ridker, P. M., Rifai, N., Rose, L., Buring, J. E., & Cook, N. R. (2002). Comparison of C-reactive protein and low-density lipoprotein cholesterol levels in the prediction of first cardiovascular events. *New England Journal of Medicine, 347*(20), 1557-1565.

Shah, T., Jonnalagadda, S. S., Kicklighter, J. R., Diwan, S., & Hopkins, B. L. (2005). Prevalence of metabolic syndrome risk factors among young adult Asian Indians. *Journal of Immigrant Health, 7*(2), 117-126.

Shammas, N. W., Lemke, J. H., Deckert, J., Toth, P. P., McKinney, D., & Dippel, E. J. (2006). Gender differences in adhering to national guidelines in a community lipid clinic. *Preventive Cardiology, 9*(4), 215-218.

Simmons, D., & Powell, M. J. (1993). Metabolic and clinical characteristics of south Asians and Europeans in Coventry. *Diabetes and Medicine, 10*(8), 751-758.

Snehalatha, C., Satyavani, K., Sivasankari, S., Vijay, V., & Ramachandran, A. (1999). Insulin secretion and action in different stages of glucose tolerance in Asian Indians. *Diabetes and Medicine, 16*(5), 408-414.

Sundquist, J., Winkleby, M. A., & Pudaric, S. (2001). Cardiovascular disease risk factors among older black, Mexican-American, and white women and men: An analysis of NHANES III, 1988-1994. Third National Health and Nutrition Examination Survey. *Journal of Amercian Geriatric Society, 49*(2), 109-116.

Tavridou, A., Unwin, N., Bhopal, R., & Laker, M. F. (2003). Predictors of lipoprotein(a) levels in a European and South Asian population in the Newcastle Heart Project. *European Journal of Clinical Investigation, 33*(8), 686-692.

Venkataraman, R., Nanda, N. C., Baweja, G., Parikh, N., & Bhatia, V. (2004). Prevalence of diabetes mellitus and related conditions in Asian Indians living in the United States. *American Journal of Cardiology, 94*(7), 977-980.

Vikram, N. K., Misra, A., Pandey, R. M., Dwivedi, M., & Luthra, K. (2004). Adiponectin, insulin resistance, and C-reactive protein in postpubertal Asian Indian adolescents. *Metabolism, 53*(10), 1336-1341.

Viswanathan, M. (1986). Diabetes health care, nutrition, and diabetes education in diabetes centers in India. *Diabetes Educator, 12*(4), 400-402.

Wasir, J. S., Misra, A., Vikram, N. K., Pandey, R. M., & Gupta, R. (2008). Comparison of definitions of the metabolic syndrome in adult Asian Indians. *Journal of Associations of Physicians of India, 56*, 158-164.

Whincup, P. H., Gilg, J. A., Papacosta, O., Seymour, C., Miller, G. J., Alberti, K. G., et al. (2002). Early evidence of ethnic differences in cardiovascular risk: Cross sectional comparison of British South Asian and white children. *British Medical Journal, 324*(7338), 635.

Wild, S., Roglic, G., Green, A., Sicree, R., & King, H. (2004). Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care, 27*(5), 1047-1053.

Yajnik, C. S., Lubree, H. G., Rege, S. S., Naik, S. S., Deshpande, J. A., Deshpande, S. S., et al. (2002). Adiposity and hyperinsulinemia in Indians are present at birth. *Journal of Clinical Endocrinology and Metabolism, 87*(12), 5575-5580.

Yusuf, S., Reddy, S., Ounpuu, S., & Anand, S. (2001). Global burden of cardiovascular diseases: Part II: Variations in cardiovascular disease by specific ethnic groups and geographic regions and prevention strategies. *Circulation, 104*(23), 2855-2864.