

# Metabolic Syndrome: Differences for Asian Americans is in Their Body Fat Percentages

Asian/Pacific Island Nursing Journal  
Volume 1(3): 70-81  
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<http://digitalscholarship.unlv.edu/apin/>

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## Abstract

Asian Americans are not frequently thought of as being obese or overweight yet some of the Asian American subgroups have a disproportionate risk for cardiovascular disease and type 2 diabetes mellitus. Although the standardized body mass index (BMI) assessment is an adequate tool for reporting secular prevalence trends for overweight/obesity across populations, it falls short in accuracy when assessing Asian Americans. In recent years more has been written about the re-evaluation of BMI cut points for normal weight, overweight, or obese Asian Americans. Additionally, the waist circumference norm was modified to indicate a smaller waist size is a risk for metabolic syndrome. The purpose of this paper is to provide an overview of the research literature on BMI and percentage of body fat as it relates to health risk for metabolic syndrome for Asian American subgroups.

Three databases were used to identify articles for this review: Google Scholar, CINAHL, and PubMed. Seven hundred twenty-six articles were initially identified as meeting the criteria; 690 articles were eliminated after a review of the article titles revealed the content did not meet the focus of this review. Of the remaining articles, 19 were eliminated after a review of the abstracts indicated they were meta-analyses, review articles, or case studies. The remaining 18 articles were included in this review.

Three common themes emerged. (1) The differences in BMI and body fat percentage are evident between Asian Americans and other ethnic groups. (2) Differences in the percentage of body fat exist between Asian American subgroups, and between Asian Americans and Asian immigrants. (3) There are differences in disease development end points when comparing Asian American subgroups and Asian immigrant subgroups.

There are differences in body fat distribution and body fat percentages as well as BMI compared to other ethnic groups for metabolic syndrome. There are also differences between Asian immigrant/Asian American subgroups whereby some are more susceptible to diabetes and cardiovascular disease. Research is necessary to determine if these differences have an underlying genetic predisposition. Additionally, researchers need to oversample Asian immigrant/Asian American participants in comparison studies and need to identify each subgroup in their research rather than aggregating Asian immigrants/Asian Americans by geographical origin or as one common group designated as a generic group of "Asians."

*Keywords:* Asian Americans, obesity, anthropometric measurements, BMI, body fat distribution

While the obesity epidemic is discussed in most major professional health journals, there is much more to learn about this major public health issue especially as it relates to the various ethnic/racial groups. Obesity can be considered the core factor in the constellation of metabolic risk factors known as metabolic syndrome (previously referred to as Syndrome X; Després, 2012; Fujimoto et al., 1999). As the epidemic of metabolic syndrome increases in the Asian American population, questions arise because Asian Ameri-

cans are less likely to be classified as overweight or obese (Ogden, Carroll, Kit, & Flegal, 2013).

Metabolic syndrome is more common in Asian Americans than in non-Hispanic Whites

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(Palaniappan, Wong, Shin, Fortmann, & Lauderdale, 2011). The reason for concern is because the Asian American population is one of the nation's fastest growing ethnic/racial groups, growing at a rate four times that of the total U.S. population (Colby & Ortman, 2014). In 2011, over 18.2 million individuals living in the United States self-identified as Asian American, with nearly two-thirds claiming to be foreign-born (Colby & Ortman, 2014). Equally important is the difference in anthropometric measurements and physiological factors associated with metabolic syndrome in this population compared to other ethnic/racial groups. These differences may indicate a greater risk for diabetes and cardiovascular disease (CVD) due to late identification and treatment for metabolic syndrome. It is imperative to identify the potential differences in anthropometric measurements because they warrant different approaches to treatment of not only the physiological parameters but also the cultural beliefs, dietary habits, and behavioral patterns.

This overview describes the characteristics of the anthropometric measurements, such as body mass index (BMI) and body fat percentage associated with metabolic syndrome among Asian Americans compared with other ethnic/racial groups in the general population (Bates, Acevedo-Garcia, Alegría, & Krieger, 2008; Yates, Edman, & Aruguete, 2004). Results indicated that the standard BMI guidelines for overweight and obesity cannot be applied to the Asian American population without modifying the standard parameters downward. Some of the research metrics for obesity using BMI and waist-to-hip ratio (body fat percentages) for Asian Americans have mixed results. One explanation is that studies have used different subgroups of Asian Americans or used Asian Americans as single aggregated study groups, making it difficult to translate findings across all subgroups.

### Background Information

According to the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (2002), individuals with three or more of the following risk factors are diagnosed with Metabolic Syndrome: (a) an elevated blood pressure equal to or greater than 130/85 mmHg, (b) a reduction of high-density lipoprotein (males: < 40 mg/dL and women: < 50 mg/dL), (c) a fasting blood sugar level of  $\geq 100$  mg/dL, (d) a waist circumference of  $\geq 40$  inches for males or  $\geq 35$  inches in women, and (e) an elevated triglyceride level of  $\geq 150$  mg/dL. Those with metabolic syndrome are two times more likely to develop CVD, five times more likely to develop type 2 diabetes mellitus (T2 DM), and more likely to develop sleep apnea, fatty liver disease, and orthopedic problems (Després et al., 2000; Ford, Giles, & Dietz, 2002).

Logically, if these risk factors are curtailed, long-term adverse effects can be prevented or minimized. Additionally, population-based and longitudinal studies indicated those with elevated BMI ( $> 30$  kg/m<sup>2</sup>, defined as obese [Center for Disease Control & Prevention (CDC), 2015]) or larger waist circumferences (males:  $\geq 40$ "; females:  $\geq 35$ "; CDC, 2015) are the most at risk for this syndrome, and ultimately at greater risk for the development of CVD and T2 DM.

The single most important factor in controlling metabolic syndrome is to prevent or reverse obesity (Han et al., 2002; Palaniappan et al., 2004). According to the CDC (2015), those with a BMI of  $> 25$  kg/m<sup>2</sup> are considered to be overweight and those with a BMI of  $> 30$  kg/m<sup>2</sup> are categorized as obese. Evidence indicates there are differences in BMI measurements for the various ethnic/racial groups with different cut point values indicating risk for disease.

Using the standard definition of obesity (BMI cut points), the CDC oversampled Asian Americans in the 2011-2012 National Health and Nutrition Education Survey. Their findings indicated the prevalence of obesity in the Asian American population was 10.8% compared to 34.9% for all U.S. adults (Ogden, Carroll, Kit, & Flegal, 2014). This finding is in contrast to several Asian American studies, which indicated an increased risk for diabetes in spite of lower BMI categorizations (Hsu et al., 2015; McNeely & Boyko, 2004; Oza-Frank, Ali, Vaccarino, & Narayan, 2009).

Metabolic syndrome in Asian Americans is poorly understood due to the lack of data supporting its prevalence. In general, data for CVD and T2 DM in Asian Americans indicated an increased number affected at lower BMI values than the standard BMI definition for overweight and obesity. Studies conducted in Asian countries such as China (Ko, Chan, Cockram, & Woo, 1999), Korea (Jee et al., 2006), Singapore (Deurenberg-Yap et al., 2001), and the Philippines and Taiwan (Gallagher et al., 2000; Palaniappan et al., 2011) also demonstrated a higher risk for CVD and T2 DM. These findings led the World Health Organization (WHO) to revise the BMI definition of overweight and obesity for Asians. The revised BMI range of 23.0-27.4 kg/m<sup>2</sup> is now considered overweight for Asians with a BMI of  $\geq 27.5$  kg/m<sup>2</sup> defined as obese (WHO, 2004; Table 1).

**Table 1.** BMI Cutoff Points for Asians vs. for Other Ethnic Groups

BMI Values	Asians	All Other Ethnic Groups
Underweight	<18.5 kg/m <sup>2</sup>	< 18.5 kg/m <sup>2</sup>
Normal	18.5-22.9 kg/m <sup>2</sup>	18.5-24.9 kg/m <sup>2</sup>
Overweight	23.0-27.4 kg/m <sup>2</sup>	25.0-29.9 kg/m <sup>2</sup>
Obese	$\geq 27.5$ kg/m <sup>2</sup>	$\geq 30.0$ kg/m <sup>2</sup>

Note. Source: WHO, 2004

## Method

This literature review focused on Asian American obesity using BMI and body fat percentages. Google Scholar, CINAHL, and PubMed were used to identify articles that met the review criteria. Key words included (a) Asian immigrants/Asian Americans and obesity, (b) Asian immigrants/Asian Americans and BMI, (c) Asian immigrants/Asian Americans and waist circumference, and (d) Asian immigrants/Asian Americans and body fat distribution. Inclusion criteria were articles related to (a) Asian adults either born in the United States or migrated to the United States; (b) Asian Americans classified as overweight or obese according to BMI or body fat percentages; (c) anthropometric measurements, such as BMI or percentage of body fat, associated with metabolic syndrome or T2 DM in Asian Americans; (d) studies in peer-reviewed journals written in English; and (e) studies published within the past two decades (1995-2015). Exclusion criteria included (a) Asian Americans/Asian immigrants younger than 18 years of age; (b) dissertations, theses, unpublished papers, and book chapters; (c) intervention studies; and (d) articles on body fat assessment in individuals with diagnosed diseases. A total of 726 articles were identified; 690 articles were eliminated based on titles not reflecting the focus of this review. Of the remaining articles, 19 did not meet inclusion criteria after reviewing the abstracts and were eliminated. After eliminating review articles, meta-analyses, and case studies, 18 articles were included in this review. Both researchers reviewed and eliminated the articles that did not meet the inclusion criteria. The authors met to discuss articles they differed on until consensus was reached.

## Results: Common Themes

Research data have indicated the relationship between BMI and body fat composition differs between the different ethnic/racial groups. Obesity as defined by BMI is a well-known risk factor for metabolic syndrome, but BMI parameters are being questioned in Asian Americans. Historically, Asian Americans are overlooked or understudied when assessing obesity rates because of the belief their rates are lower than other ethnic groups. The studies reviewed here were peer-reviewed journal articles involving Asian Americans or immigrant Asians living in the United States with anthropometric measurements associated with risk for diabetes and CVD. There were several studies included in this review of disaggregated Asian data analyses which have shown heterogeneity in health profiles. The results from these studies should be interpreted with caution. This review identified common themes discussed below. A total of 2,870,326 study participants were included in this review.

## Differences in Body Fat and BMI

The comparison studies of overweight or obese U.S. born Asians compared to their foreign-born counterparts (Palaniappan et al., 2011) demonstrated those living in the United States (based on length of residency in the United States) correlated with increased weight or elevated BMI (Jih et al., 2014; Lauderdale & Rathouz, 2000; Park, Neckerman, Quinn, Weiss, & Rundle, 2008; Sánchez-Vaznaugh, Kawachi, Subramanian, & Acevedo-Garcia, 2008). Because most of these studies are simple comparisons, prevalence or descriptive analyses, the true nature of obesity and its related disease associations document contradictory data for this ethnic group. Additionally, studies assessing the association between acculturation (taking on the Western lifestyle, including eating Western foods) and BMI among Asians who migrated to Western countries are inconsistent. For example, some found no association (Kaushal, 2009; Park et al., 2008) while others found an association (Gomez, Kelsey, Glaser, Lee, & Sidney, 2004; Oakkar et al., 2015; Oza-Frank & Narayan, 2010).

## Paradox of BMI Values and Percentage of Body Fat

From a physiological perspective, obesity is not the degree of body weight but the percentage of accumulated body fat that is related to disease risk factors. The realization that some ethnic groups have higher percentages of body fat content compared to their stated BMIs came to light with the discovery that Asians have lower BMIs but higher body fat percentages compared to Caucasians of the same age and sex. Seemingly, the tendency for central or abdominal obesity might be greater for Asian Americans when compared with non-Asians. It is this left shift in BMI with higher body fat percentages that led to the reassessment of BMI cut points for Asian Americans.

Gallagher et al. (2000) found differences in the paradox of lower BMI and higher percentage of body fat in Japanese living in the United States and the United Kingdom compared to Caucasians and African Americans. According to Araneta and Barrett-Connor (2005), Filipino women living in California with normal adjusted BMIs of  $< 23 \text{ kg/m}^2$  had more intra-abdominal visceral fat compared to Caucasian and African-American women with normal BMIs of  $< 25 \text{ kg/m}^2$ .

## Differences Between Asians

Weight studies assessing subgroups of Asian Americans yielded different findings across Asian American populations suggesting all Asian Americans should not be grouped together as one ethnic/racial

category. All Asian American subgroups are not similar when comparing BMI and fat percentages. According to Oakkar et al. (2015), a substantial heterogeneity is reflected in the longitudinal data that assessed acculturation and BMI. Among the foreign-born Asians in their California Men's Health Study, they found that Filipinos and Koreans had higher rates of weight gain compared to Chinese. They postulated their findings to mean BMI curves differ by Asian American subgroups.

Several studies over the past two decades that have compared body fat percentages among various Asian American subgroups have indicated not all Asian Americans are equal in body fat composition (Albrecht et al., 2013; Gomez et al., 2004; Lauderdale & Rathouz, 2000; Oza-Frank et al., 2009). These findings in Asian Americans are supported by research conducted in other Asian countries. For example, Deurenberg-Yap et al. (2001) found distinct differences in BMI/percentage body fat composition (as measured by waist-to-hip ratios) with Chinese, Indonesians, and Thais at greater risk for co-morbidities for CVD with lower BMIs and waist-to-hip ratios. Another comparison of Chinese living in Beijing, Hong Kong, and New York also showed differences in BMI/body fat percentages (Deurenberg-Yap, Schmidt, van Staveren, & Deurenberg, 2000).

Lauderdale and Rathouz (2000) assessed 254,153 individuals from six different Asian American ethnic groups: Chinese, Filipino, Japanese, Asian Indian, Korean, and Vietnamese females and males ranging in age from 18-59 years. This cross-sectional study measured body weight, height, calculated BMI, age, sex, years lived in the United States, household income, and household size. Results revealed the percentage overweight ranged from 17% for Vietnamese males compared to 42% for Japanese males. For women, the percentage overweight ranged from 9% for Chinese and Vietnamese and 25% for Asian Indians. According to Oza-Frank et al. (2009), regardless of BMI classification, Asian Indians and Filipinos had higher prevalence rates of overweight (34-37% and 35-47%, respectively) compared to Chinese (30-38%).

### ***Differences in End Point Disease Development***

T2 DM is one of the disease conditions associated with obesity and the development of metabolic syndrome. There are disproportionate differences in diabetes rates between the various ethnic groups. McNeely and Boyko (2004) demonstrated Asians have lower BMI values but tend to have a disproportionate disparity in cardiovascular mortality due to co-morbidities such as uncontrolled blood sugar levels, elevated lipid levels, and high blood pressure. According to Karter et al. (2013), high rates of diabetes in

Asian Americans (Japanese, Chinese, Korean, Vietnamese, and Filipinos) can lead to co-morbid cardiovascular complications – assessed 210,632 participants from the Northern California Kaiser Permanente diabetes study. Pacific Islanders, South Asians, and Filipinos had the highest rates of diabetes, but findings were obscured by lower rates of participants among the larger Asian groups (i.e., Chinese) and several smaller Asian American subgroups. Jih et al. (2014) found overweight and obesity was highest among Filipinos. They concluded Filipinos should be the priority for overweight and obesity prevention as Filipinos and other Asian American subgroups in their study had higher prevalence rates for diabetes.

Studies of Southeast Asians living in the United States were found to have significantly higher prevalence of T2 DM (Araneta & Barrett-Connor, 2005) with rates as high as 23% compared to Whites (6%), African Americans (18%), and Latinos (17%; Araneta & Barrett-Connor, 2005). According to results from the SEARCH for Diabetes in Youth Study Group (Hamman et al., 2014) it is becoming more and more difficult to differentiate between type 1 and T2 DM in those younger than 35 years of age in East Asia because BMI (approximately 24 kg/m<sup>2</sup>) is equally low for both types of disease. This is not the case in other ethnic groups where the average BMI associated with T2 DM is around 27 kg/m<sup>2</sup>.

While not part of this review, international studies have supported the findings of Asians living in the United States. For example, international studies comparing T2 DM between white Europeans and South Asian (i.e., Chinese, Japanese) subgroups found South Asians were more likely to develop T2 DM (Deurenberg-Yap, 2000; Ko et al., 1999; Sohani et al., 2014; Yajnik, 2002).

Ethnic/racial subgroups that may have a higher incidence of co-morbid diseases such as diabetes and CVD are Native Hawaiians and other Pacific Islanders due to their propensity for obesity. The association of high BMI values and a greater percentage of body fat associated with T2 DM and heart disease is a logical progression of disease trajectory for Native Hawaiians and other Pacific Islanders. This is not so in the Asian American population as the current research is beginning to uncover the BMI paradox associated with similar diseases in Asians. East Asians (Koreans, Chinese, and Japanese) are more likely to have smaller BMIs or waist circumferences but have a higher associated risk for developing T2 DM. The Japanese American Community Diabetes Study helped explain this paradox. This prospective study of 2nd and 3rd generation Japanese Americans found visceral fat measured by computed tomography was the overarching risk factor for the development of T2 DM, hypertension, coronary heart disease, insulin resistance, and

**Table 2.** Summary of Research Studies Included in the Review

Authors	Study Design & # of Participants	Age	Ethnic Groups	Aim	Measures	Outcomes
Albrecht et al. (2013)	Secondary data analysis of longitudinal study <i>N</i> = 2,288	45-84	<ul style="list-style-type: none"> <li>Hispanic</li> <li>Chinese</li> </ul>	Examine whether foreign-born participants experienced greater increases in BMI and waist circumference than US-born over a median follow-up of five years	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> <li>Waist circumference</li> </ul>	<ul style="list-style-type: none"> <li>Foreign-born Hispanics and Chinese had lower adjusted mean BMI and waist circumference at base-line compared to US-born Hispanics and Chinese</li> <li>Mexican Hispanics had greater waist circumference over time compared to US-born Mexican Hispanics</li> <li>Foreign-born Mexican Hispanics had a faster rate of waist circumference increase compared to foreign-born non-Mexican Hispanics</li> </ul>
Araneta & Barrett-Connor (2005)	Descriptive secondary data analysis <i>N</i> = 570	55-80	<ul style="list-style-type: none"> <li>Filipino females</li> <li>African Americans females</li> <li>Caucasian females</li> </ul>	Examine ethnic differences in visceral adipose tissue assessed by computed tomography and type 2 diabetes risk in women without cardiovascular disease	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> <li>Visceral adipose tissue</li> </ul>	<ul style="list-style-type: none"> <li>Filipino women had lower BMI and waist girth compared to African-American women</li> <li>Filipino women had significantly higher visceral adipose tissue compared to the other two groups</li> <li>Visceral adipose tissue correlated with BMI and waist circumference better for whites compared to Filipinos</li> <li>Age-adjusted type 2 diabetes risk was higher for Filipino women compared to the other groups</li> </ul>
Bates, Acevedo-Garcia, Alegría, & Krieger (2008)	Descriptive data from the National Latino & Asian American Survey (2002-2003) <i>N</i> = 4,649	≥18	<ul style="list-style-type: none"> <li>Puerto Rican</li> <li>Cuban</li> <li>Mexican</li> <li>Other Latinos</li> <li>Chinese</li> <li>Filipino</li> <li>Vietnamese</li> <li>Other Asian Americans</li> </ul>	Examine BMI and obesity among a representative sample of first, second, and third generation Latinos and Asian Americans to uncover associations with nativity or country of origin	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> </ul>	<ul style="list-style-type: none"> <li>Great heterogeneity in BMI and obesity by country of origin</li> <li>BMI increase in later generations among most subgroups</li> <li>Different patterning for Latinos and Asian Americans in nature &amp; distribution changes in BMI with generational status in the US</li> </ul>
Fujimoto et al. (2012)	Cross-sectional <i>N</i> = 658	≥ 18	<ul style="list-style-type: none"> <li>Several generations of Japanese Americans</li> </ul>	Learn more about the etiology and pathogenesis of type 2 diabetes in Japanese Americans	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> <li>Visceral adiposity</li> <li>Type 2 diabetes</li> </ul>	<ul style="list-style-type: none"> <li>Japanese Americans had a greater risk for type 2 diabetes with increased weight gain, especially visceral adiposity</li> </ul>

Authors	Study Design & # of Participants	Age	Ethnic Groups	Aim	Measures	Outcomes
Gallagher et al. (2000)	Cross-sectional N = 1,626	20-79	<ul style="list-style-type: none"> <li>Whites</li> <li>Blacks</li> <li>Japanese</li> </ul>	Examine an approach for developing percentage of body fat ranges	<ul style="list-style-type: none"> <li>BMI</li> <li>DXA</li> <li>Tritium or deuterium dilution volume</li> <li>Bone mineral mass</li> </ul>	<ul style="list-style-type: none"> <li>African-American women had the highest mean weight</li> <li>Japanese men and women had the lowest mean weight</li> <li>Japanese had the highest percentage body fat for any given BMI</li> <li>Predictive models for Japanese indicated different percentage body fat from that predicted for African Americans and Whites</li> </ul>
Gomez, Kelsey, Glaser, Lee, & Sidney (2004)	Case-controlled study N = 5,581 (3,168 participants, 2,413 controls)	≥ 45	<ul style="list-style-type: none"> <li>Chinese</li> <li>Japanese</li> <li>Filipinos</li> <li>Multiple Race Asian</li> </ul>	Determine how risk factors for disease vary among Asian subgroups	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> <li>Smoking history</li> <li>Dietary factors                             <ul style="list-style-type: none"> <li>soy milk</li> <li>tofu</li> <li>alcohol</li> </ul> </li> <li>Physical activity</li> <li>Overall health</li> <li>History of chronic disease</li> </ul>	<ul style="list-style-type: none"> <li>Japanese and Chinese had lower BMI than other Asian subgroups</li> <li>Subgroups born in the US were associated with having BMIs &gt; 25</li> <li>Japanese and multiple race Asians were more likely to smoke</li> <li>Filipinos and multiple race Asians were more likely to start smoking at age 18 or younger</li> <li>Filipinos and multiple race Asians were more likely to report diabetes</li> </ul>
Huang et al. (1996)	Cross-sectional N = 8,006	> 18	<ul style="list-style-type: none"> <li>Japanese males in the US</li> </ul>	Determine the association between acculturation and prevalence of diabetes	<ul style="list-style-type: none"> <li>BMI</li> <li>Physical activity index</li> <li>Oxygen consumption</li> <li>percentage of calories for carbohydrates and fats</li> </ul>	<ul style="list-style-type: none"> <li>Number of years lived in Japan was inversely associated with the development of diabetes</li> <li>Japanese diet (from native country) was inversely associated with diabetes</li> </ul>
Jih et al. (2014)	Secondary data analysis of the 2009 adult California Health Interview Survey N = 45,946	≥ 18	<ul style="list-style-type: none"> <li>non-Hispanic Whites</li> <li>African Americans</li> <li>Hispanics</li> <li>Vietnamese</li> <li>Chinese</li> <li>Korean</li> <li>Filipino</li> <li>South Asian</li> </ul>	<p>Examine the prevalence of overweight/obesity using BMI cut points recommended by WHO for Asian Americans</p> <p>Examine BMI cut points and Diabetes in Asian American subgroups</p>	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> </ul>	<ul style="list-style-type: none"> <li>Highest rates of overweight/obesity were among Filipinos (78.6%) higher than non-Hispanic Whites and similar to African Americans and Hispanics</li> <li>Diabetes prevalence was higher among Vietnamese, Koreans, Filipinos, and South Asians with BMIs 23.0-24.9 kg/m<sup>2</sup></li> <li>Using WHO BMI cut points of 27.5-28.9 kg/m<sup>2</sup>, Koreans, Filipinos, and Japanese had the highest prevalence of diabetes</li> </ul>

Authors	Study Design & # of Participants	Age	Ethnic Groups	Aim	Measures	Outcomes
Karter et al. (2013)	Prospective cohort analysis N = 2,123,548	≥ 18	<ul style="list-style-type: none"> <li>• Japanese</li> <li>• Latino</li> <li>• African American</li> <li>• Filipino</li> <li>• Chinese</li> <li>• Multiracial</li> <li>• Japanese</li> <li>• Native Americans</li> <li>• Pacific Islander</li> <li>• South Asian</li> <li>• Southeast Korean</li> <li>• Southeast Vietnamese</li> </ul>	Establish prevalence and incidence of diabetes among specific subgroups of Asians and Pacific Islanders in the US population with access to care at Kaiser Permanente Northern California	<ul style="list-style-type: none"> <li>• Data analysis for age-standardized and sex-adjusted diabetes prevalence</li> </ul>	<ul style="list-style-type: none"> <li>• A considerable prevalence of diabetes with increasing BMI</li> <li>• Pacific Islanders, South Asians, and Filipinos had the highest prevalence</li> </ul>
Lauderdale & Rathouz (2000)	Cross-sectional N = 254,153	18-59	<ul style="list-style-type: none"> <li>• Vietnamese</li> <li>• Japanese</li> <li>• Chinese</li> <li>• Asian Indians</li> <li>• Filipinos</li> <li>• Korean</li> </ul>	<p>Examine BMI of Asian adults</p> <p>Investigate whether BMI varies by nativity (foreign vs. native born) years in the US or socioeconomic status</p>	<ul style="list-style-type: none"> <li>• Height</li> <li>• Weight</li> <li>• BMI</li> <li>• Age</li> <li>• Sex</li> <li>• Years in the US</li> <li>• Household income</li> <li>• Household size</li> </ul>	<ul style="list-style-type: none"> <li>• Vietnamese men had lower percentage of overweight compared to Japanese males</li> <li>• Vietnamese and Chinese women had lower percentages of overweight compared to Asian-Indian women</li> <li>• Adjusted for age and ethnicity, odds ratio for obesity was 3.5 for women and 4.0 for men born in the US vs. foreign-born</li> <li>• Foreign-born Asians with greater risk for overweight or obesity lived in the US longer</li> <li>• Association between household income for US-born Asian women was similar to the US-born Whites and blacks, but weaker for foreign-born Asian Americans</li> </ul>
McNeely & Boyko (2004)	Cross-sectional N = 163,584	≥30	<ul style="list-style-type: none"> <li>• Asian Americans</li> <li>• non-Hispanic Whites</li> <li>• Blacks</li> <li>• Hispanics</li> <li>• Native Americans</li> <li>• Pacific Islanders</li> </ul>	Compare the prevalence of type 2 diabetes in Asian Americans with other racial and ethnic groups in the US using data from the 2001 Behavioral Risk Factor Surveillance System	<ul style="list-style-type: none"> <li>• Height</li> <li>• Weight</li> <li>• Race/ethnicity</li> <li>• Health insurance status</li> <li>• Diabetes</li> </ul>	<ul style="list-style-type: none"> <li>• Similar proportion of Asians and non-Hispanic Whites reported diabetes</li> <li>• When accounting for lower BMI for Asian Americans, the adjusted prevalence of diabetes was 60% higher in Asian Americans</li> </ul>



Authors	Study Design & # of Participants	Age	Ethnic Groups	Aim	Measures	Outcomes
Ogden, Carroll, Kit, & Flegal (2014)	Cross-sectional N = 5,181 adults	≥ 20	<ul style="list-style-type: none"> <li>• non-Hispanic Blacks</li> <li>• non-Hispanic Asians</li> <li>• Hispanics</li> <li>• non-Hispanic Whites</li> </ul>	Provide detailed obesity trend analyses by age among adults	<ul style="list-style-type: none"> <li>• BMI</li> <li>• Weight</li> <li>• Height</li> </ul>	<ul style="list-style-type: none"> <li>• 2/3 of adults were either overweight or obese</li> <li>• Prevalence was higher among women</li> <li>• Prevalence highest among the middle-aged group and adults aged 60 years and older</li> <li>• Grade 3 obesity prevalence highest for non-Hispanic blacks</li> <li>• 10.9% of non-Hispanic Asian adults were obese</li> <li>• No considerable change in obesity prevalence in adults between 2003-2004 and 2011-2012.</li> </ul>
Oakkar et al. (2015)	Prospective longitudinal N = 1,549	44-71	<ul style="list-style-type: none"> <li>• Chinese</li> <li>• Japanese</li> <li>• Vietnamese</li> <li>• Korean</li> </ul>	Determine differences in changes in BMI across age by residence (US vs. Asia) and age at immigration using longitudinal data on BMI prior to and after immigration	<ul style="list-style-type: none"> <li>• BMI at ages 30,40, 50, and 60 years of age</li> <li>• Self-report weight and current height</li> </ul>	<ul style="list-style-type: none"> <li>• BMI increases were smaller for Asians who lived in Asia prior to migrating to the US compared to those already living here</li> <li>• Those who migrated to the US prior to 40 years of age had higher BMI compared to those who migrated at a later age</li> </ul>
Oza-Frank, Ali, Vaccarino, & Narayan (2009)	Descriptive Data on Asian American adults N = 147,705	18-74	<ul style="list-style-type: none"> <li>• Asian Indians</li> <li>• Chinese</li> <li>• Filipinos</li> <li>• Non-Hispanic Whites</li> </ul>	Compare the prevalence of diabetes among Asian Americans by the WHO and US BMI classifications	<ul style="list-style-type: none"> <li>• Height</li> <li>• Weight</li> <li>• BMI</li> </ul>	<ul style="list-style-type: none"> <li>• Regardless of classification, Asian Indians and Filipinos had higher prevalence of obesity compared to Chinese</li> <li>• Asian Indians also had higher ethnic prevalence for diabetes than the other Asian Americans</li> </ul>
Oza-Frank & Narayan (2010)	Cross-sectional data from National Health Interview Survey (1997-2005) N = 7,414	18-74	<p>Individuals migrating from the following countries to live in the US:</p> <ul style="list-style-type: none"> <li>• Mexico</li> <li>• South America</li> <li>• Europe</li> <li>• Russia</li> <li>• Africa</li> <li>• Middle</li> <li>• Indian subcontinent</li> <li>• Southeast Asia</li> </ul>	Establish an association between length of residence in US and overweight among immigrants by region of birth and age at arrival	<ul style="list-style-type: none"> <li>• Self-report survey</li> </ul>	<ul style="list-style-type: none"> <li>• Overweight odds three times higher in immigrants from Mexico, South America, Europe, Russia, Africa, and Middle East for those residing in the US for greater than 15 years</li> <li>• Those who migrated from Indian subcontinent and South East Asians had no association with length of stay in the US and overweight</li> <li>• South East Asians and Africans had lower odds of being overweight</li> <li>• For African and Southeast Asian women aged 24-44 years of age, the odds of being overweight were greater than other ethnic/racial groups</li> </ul>



Authors	Study Design & # of Participants	Age	Ethnic Groups	Aim	Measures	Outcomes
Park, Neckerman, Quinn, Weiss, & Rundle (2008)	Cross-sectional <i>N</i> = 13,011	≥ 18	<ul style="list-style-type: none"> <li>Asians</li> <li>Black-Caribbean</li> <li>Hispanic</li> </ul>	Examine the theory that immigrant groups length of residence in the US and across generations results in weight gain	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> <li>Diet</li> <li>Physical activity</li> </ul>	<ul style="list-style-type: none"> <li>Foreign-born associated with significantly lower BMI but this association was weakest in Asians</li> <li>Among Hispanics, association between foreign birth and BMI was stronger in low linguistic isolation neighborhoods</li> <li>Increased residence in the US was significantly associated with higher BMI</li> </ul>
Palaniappan, Wong, Shin, Fortmann, & Lauderdale (2011)	Descriptive retrospective (self-report) data analysis using electronic medical records from a health care organization in San Francisco <i>N</i> = 47,507	≥ 35	<ul style="list-style-type: none"> <li>Chinese</li> <li>Filipino</li> <li>Asian Indian</li> <li>Japanese</li> <li>Korean</li> <li>Vietnamese</li> <li>non-Hispanic White</li> </ul>	Examine the relationship between BMI and metabolic syndrome for Asian Americans and non-Hispanic Whites given the ethnic/racial heterogeneity of the ability to predict metabolic syndrome using BMI	<ul style="list-style-type: none"> <li>Height</li> <li>Weight</li> <li>BMI</li> <li>Metabolic syndrome</li> </ul>	<ul style="list-style-type: none"> <li>Overall metabolic syndrome rates were higher for Asians compared to non-Hispanic Whites</li> <li>BMI of 25 kg/m<sup>2</sup> at age 55, the predicted rate of metabolic syndrome for Non-Hispanic White women was 12% compared to 30% for Asian females</li> </ul>
Sánchez-Vaznaugh, Kawachi, Subramanian, Sánchez, & Acevedo-García (2008)	Cross-sectional population data from the 2001 California Health Interview Survey <i>N</i> = 37,350	25-64	<ul style="list-style-type: none"> <li>Whites</li> <li>Blacks</li> <li>Hispanics</li> <li>Chinese</li> <li>Vietnamese</li> <li>Korean</li> <li>Cambodian</li> <li>Pacific Islander</li> <li>Other Asian</li> <li>Asian with 2 or more ethnicities</li> </ul>	<p>Investigate the association of birthplace and US length of residence with BMI</p> <p>Investigate whether the influence of birthplace-length of residence on BMI varied by education, gender, and race/ethnicity</p>	<ul style="list-style-type: none"> <li>Weight</li> <li>Height</li> <li>BMI</li> </ul>	<ul style="list-style-type: none"> <li>Foreign-born adults had lower BMI than US-born adults</li> <li>Longer residence in the US was associated with higher BMI</li> <li>The effect of birthplace-length of US residence on BMI difference by education, gender, and race/ethnicity</li> </ul>

Note. US = United States

metabolic syndrome (Fujimoto et al., 2012). It is becoming apparent that diagnosing metabolic syndrome in Asian individuals using the same criteria for other ethnic groups is inappropriate (see Table 2).

## Discussion

Given the currently available data on Asian immigrants/Asian Americans, it is now evident that lower BMIs need to be used to distinguish normal weight individuals from those that are overweight or obese. It is also becoming increasingly evident that despite lower BMIs, Asian immigrants/Asian Americans have greater percentages of body fat compared to their Caucasian counterparts given similar age, sex, and BMI. Given these known factors, there are still many questions left unanswered as evident from the results of this review.

There are several areas identified in the literature that differentiates Asian immigrants/Asian Americans and other ethnic/racial groups for BMI measurements and body fat percentages. It is evident from this analysis that there are differences in measurements between Asian immigrant/Asian American subgroups. Because the data from the various studies have produced mixed results, it is clear a concerted effort is needed to collect data that builds on the current knowledge to strengthen this body of research. One way to help produce the necessary data is by oversampling Asian immigrant/Asian American subgroups. By doing so, a better understanding of the relationship of body fat for the various Asian subgroups and the risk for CVD and diabetes may emerge. Another important area identified from this literature review is the need to use the modified BMI cut point for Asian immigrants/Asian Americans for greater accuracy in identifying risk for disease. The BMI cut points used in longitudinal prospective studies have verified that recommended BMI modifications are accurate for the Asian immigrant/Asian American populations.

The focus of future research studies needs to use a more global perspective comparing subgroups of Asians in their native countries to those who migrate to the United States. Conducting longitudinal comparison studies looking particularly at acculturation and generational changes in BMI and disease risk or disease patterns can help to generate data on health disparities among the Asian immigrant/Asian American subgroups; an important first step to devising more effective disease prevention strategies for this population. Greater attention should be paid to the socioeconomic status of immigrant Asians and assimilation patterns to determine the associations of life style behaviors with the development of weight gain, specifically body fat distribution and BMI. Additionally, studies need to be designed to consistently include the

various subgroups of Asian immigrants/Asian Americans to discern the differences in body fat distribution and risk for developing CVD and T2 DM. Many of the studies in this review included Asian immigrant/Asian American subgroupings as an aggregate group, this is not the most desirable research design. With approximately 23 different Asian subgroups; some with smaller numbers in the United States (i.e., Hmong, Thailanders, Cambodians, etc.), potential study participants' ethnic/racial subgroups should be identified to yield more valuable information. There is some support for differences in BMI/body fat percentage in some of the Asian immigrant/Asian American subgroups rendering them more susceptible for CVD. What is not clear is the degree to which genetics influences this relationship. Genetics may play a more important role in the development of metabolic syndrome in some Asian immigrant/Asian American subgroups; particularly a genetic predisposition of vulnerability with exposure to the Western lifestyle.

## Conclusion

This review indicates Asian immigrants or Asian Americans have an increased risk for diabetes and CVD with lower BMI cut points. At lower BMI parameters, Asian Americans have greater percentages of body fat which garners the risk for metabolic syndrome. While it is important to continue research, this finding also has clinical implications. Traditionally, research evidence takes approximately 17 years to become a standard guideline in practice. Initiating treatment based on this modified BMI cut point, now rather than waiting, may help prevent or contribute to improved health care and overall quality of life for Asians.

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