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A SYSTEMATIC REVIEW OF OVERWEIGHT, OBESITY, AND TYPE 2 DIABETES AMONG ASIAN AMERICAN SUBGROUPS

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Abstract

This systematic review synthesizes data published between 1988 and 2009 on mean BMI and prevalence of overweight, obesity, and type 2 diabetes among Asian subgroups in the U.S. We conducted systematic searches in PubMed for peer-reviewed, English-language citations that reported mean BMI and percent overweight, obesity, and diabetes among South Asians/Asian Indians, Chinese, Filipinos, Koreans, and Vietnamese. We identified 647 database citations and 23 additional citations from hand-searching. After screening titles, abstracts, and full-text publications, 97 citations remained. None were published between 1988 and 1992, 28 between 1993 and 2003, and 69 between 2004 and 2009. Publications were identified for the following Asian subgroups: South Asian (n=8), Asian Indian (n=20), Chinese (n=44), Filipino (n=22), Korean (n= 8), and Vietnamese (n=3). The observed sample sizes ranged from 32 to 4245 subjects with mean ages from 24 to 78 years. Among samples of men and women, the lowest reported mean BMI was in South Asians (22.1 kg/m^2), and the highest was in Filipinos (26.8 kg/m^2). Estimates for overweight (12.8 - 46.7%) and obesity (2.1 – 59.0%) were variable. Among men and women, the highest rate of diabetes was reported in Asian Indians with BMI ≥ 30 kg/m^2 (32.9%, age and sex standardized). This review suggests heterogeneity among U.S. Asian populations in cardiometabolic risk factors, yet comparisons are limited due to variability in study populations, methods, and definitions used in published reports. Future efforts should adopt standardized methods to understand overweight, obesity and diabetes in this growing U.S. ethnic population.

Keywords

Asian; BMI; diabetes; ethnicity; obesity; overweight

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Conflict of Interest

The authors have no conflict of interest.

INTRODUCTION

Between 2000 and 2010, the United States (U.S.) Asian population grew by 46%, to 17.3 million, the highest percentage growth of any racial group during that time period. The three largest Asian American subgroups are Chinese (3.8 million), Filipino (3.2 million), and Asian Indian (2.8 million) [1]. Despite continued growth of general and specific Asian American sub-populations, studies still group them into one large category, potentially missing important heterogeneity in disease burden and risk. This is especially true with regard to overweight, obesity and diabetes, chronic conditions of increasing public health significance due to increasing prevalence worldwide. However, the estimated burden of these conditions across Asian American subgroups in the U.S. is difficult to quantify because data disaggregated by Asian American subgroups are fragmented in the literature. The aim of this review is to systematically synthesize data about overweight, obesity, and diabetes among specific Asian American groups. The resulting synthesis will qualitatively summarize available estimates on the prevalence of overweight, obesity, and diabetes among those specific Asian American subgroups with high immigration rates to the U.S. over the past 20 years, specifically South Asians (Asian Indian, Bangladeshi, Bhutanese, Pakistani, Nepalese, and Sri Lankan), Chinese, Filipino, Korean, and Vietnamese.

METHODS

We performed a systematic search for peer-reviewed studies published in English using PubMed (1988 – 2009). Search strategies included Medical Subject Heading (MeSH) terms and keywords. For overweight, obesity, and diabetes, search terms included “body mass index,” “overweight,” “obesity,” “diabetes mellitus,” and “diabetes mellitus, Type 2.” The search terms for Asian groups included country ethnology, “emigrant,” “immigrant,” and “United States.” Because South Asia and South Asian are both commonly used and capture some of the subgroups of interest, we decided to search for South Asia by keyword (“South Asian*”). Additional studies were retrieved through a hand search of the citations listed in the publications of PubMed search results and from recent review articles on the topics of interest.

Inclusion And Exclusion Criteria

An article was eligible for inclusion if it presented original research in English language collected in the U.S. or a U.S. territory between 1988 and 2009, including 2009 electronic publications ahead of 2010 print. Inclusion criteria were designed to retrieve studies that reported prevalence of obesity, overweight, and diabetes among various Asian American subgroups (South Asians, Asian Indian, Pakistani, Bangladeshi, Sri Lankan, Chinese, Filipino, Korean, and Vietnamese). Articles containing study samples with origin from two or more South Asian countries were exclusively categorized into the South Asian subgroup. Given that Asian Indians, Pakistanis, etc. are part of South Asian ancestry, these categories could be combined for a more generalized analysis, however, for the purpose of this review, South Asian was treated as a separate category in accordance with database search strategies. Articles were included if they contained data on mean body mass index (BMI), percent overweight, percent obesity, or percent diabetes. Only articles with samples sizes of

at least 30 participants in the specific Asian American subgroups of interest were included. Studies that included individuals less than 18 years of age, living outside the U.S., or participating in data collection outside the time period of interest (1988-2009) were excluded. Other exclusion criteria are listed as follows: studies that only selected for people with diabetes or other poor health conditions; studies using non-representative samples matched by BMI or diabetes; and studies examining gestational diabetes mellitus or weight change during pregnancy.

Study Selection

The selection of articles for inclusion was conducted through two screening phases. The first phase included a review of abstracts for inclusion and exclusion criteria. All abstracts were reviewed by the first reviewer (LRS) and by an independent second reviewer (MBW or ROF). Discrepancies about inclusion of studies were resolved through consensus with a third person serving as a non-reviewing arbitrator (MBW or ROF). Remaining abstracts were included in the second screening phase in which each reviewer applied inclusion and exclusion criteria to full-text articles.

Data Extraction

For each publication retrieved and meeting inclusion and exclusion criteria, data were extracted using a standardized form. Key measures extracted included mean BMI, percent overweight or obese defined by BMI strata, and percent diabetes defined by self-report, fasting blood glucose, random (non-fasting) blood glucose, or two-hour, post challenge blood glucose. Percent overweight and percent obesity were defined as mutually exclusive ranges of BMI. Publications that defined overweight using a BMI range that lacked an upper BMI bound (e.g., BMI $\geq$25 kg/m^2) were included in this review, with data categorized into combined overweight and obesity. Other extracted data included study cohort, year(s) of data collection, study design, characteristics of the study population (ethnicity/nationality, sex, age range, etc.), sample size, and measurement methods (e.g., self-report, fasting blood glucose).

RESULTS

Literature Search

Our searches yielded 647 citations from PubMed and 23 citations from hand searching of references. After the first screening phase of titles and abstracts, 547 citations were excluded, leaving 123 articles for full-text review. The second screening phase of the full-text articles resulted in the exclusion of 26 additional articles, and 97 articles remained for data extraction (Figure 1). Disagreement between reviewers occurred for only nine citations (1.3%).

Study Characteristics

Articles were identified for the following Asian subgroups: South Asian (n=8), Asian Indian (n=20), Chinese (n=44), Filipino (n=22), Korean (n= 8), and Vietnamese (n=3). Most articles reported on one Asian subgroup, however six reported on two or more Asian subgroups as defined for this review [2-7], hence the summation of articles by subgroup was

greater than 97. In all studies, ethnicity was defined by participant self-report of ethnicity, origin, or ancestral origin. Although searches were conducted for studies with Bangladeshi, Bhutanese, Nepalese, Pakistani, or Sri Lankan individuals, no articles were found for these groups. Of the 97 articles in the systematic review, nearly half (n=46) were analyses of one of the following seven studies: Multi-Ethnic Study of Atherosclerosis [8-25] (MESA, n=18), Study of Women's Health Across the Nation [26-37] (SWAN, n=12), Filipino Women's Health Study [38-44] (n=7), Kōhala Health Research Project/Native Hawaiian Health Research Project [41, 45, 46] (NHHR, n=3), Behavioral Risk Factor Survey in Guam [47, 48] (BRFS, n=2), University of California San Diego (UCSD) Rancho Bernardo Study [49, 50] (n=2), and National Health Interview Survey [5, 7] (NHIS, n=2). Almost all articles reported cross-sectional data for the variables of interest; only two SWAN studies [27, 33] provided longitudinal data. Nationally representative data were sparse and limited to articles reporting NHIS data; however, several articles reported on studies with multi-center recruitment, including MESA (six centers throughout the U.S.: Baltimore, MD; Chicago, IL; Forsythe County, NC; Los Angeles, CA; New York City, NY; and St. Paul, MN) and the Diabetes Among Indian Americans (DIA) study [51] (seven urban sites: Houston, TX; Phoenix, AZ; Washington, DC; Boston, MA; San Diego, CA; Edison, NJ; and Parsippany, NJ). A quarter of all studies utilized random sampling methods (n=26).

The number of studies representing specific Asian subgroups is proportional to the population sizes of Asian subgroups in the U.S.; Chinese were represented in the most studies (47% of all studies, largest U.S. Asian subgroup) followed by South Asians and Filipinos (27% and 24%, respectively, the 3rd and 2nd largest U.S. Asian subgroups) (Figure 2). Additionally, the number of studies reporting data on Asian-specific subgroups increased from 1988-2009 (Figure 3), with the greatest number of publications with Chinese participants apparent after 2002. The observed sample sizes in the 97 articles ranged from 32 subjects to 4245 subjects. The mean age reported across studies ranged from 24 to 78 years. The ages of participants in the most common studies were 45-84 years in MESA, 40-55 in SWAN, 18 years and older in NHIS, 18 to 95 years in NHHR, and 40-76 years in the Filipino Women's Health Study. Prevalence estimates of interest were variable and wide-ranging across all subgroups. Only 20% of all articles reported prevalence data that were adjusted for age, sex, and/or other factors in the study sample or that were standardized for age, sex, and/or other factors to another population. Such data were provided for five Asian Indian [5, 51-54] articles, two Chinese [2, 5] articles, nine Filipino [2, 5, 38-41, 47, 50, 55] articles, two Korean [56, 57] articles, and one Vietnamese [58] article. None were reported for the South Asian category. Hereafter, reported values are crude unless otherwise noted. Of 32 articles providing prevalence of overweight and/or obesity, 63% (n=20) reported only conventional definitions for overweight or obesity (i.e., 25≤BMI<30, BMI ≥30 kg/m^2) or similarly (e.g., 26≤BMI≤30 kg/m^2). Five articles defined overweight and obesity according to 2004 WHO Asian-specific cut-points [59] (BMI 23.0 – 27.4 kg/m^2 and BMI ≥ 27.5 kg/m^2, respectively) or similarly (obesity as BMI ≥ 27.8 kg/m^2) [5, 51, 53, 60, 61]. Six studies defined overweight without an upper BMI bound (i.e., as BMI ≥ 23; BMI > 23; BMI >25; or BMI ≥ 25 kg/m^2) [4, 62-66]. Over half (n=52) of all articles reported prevalence of diabetes, defining diabetes by one or more of the following methods: self-report (n=42, includes self-report of diagnosis or diabetes medication usage), fasting blood glucose (n=

32), two-hour glucose tolerance (n=11), or random (nonfasting) blood glucose (n=1). Five articles did not provide the method used to assess diabetes [23, 67-70].

Summary of BMI, Overweight, Obesity, and Diabetes across Asian Subgroups

Among men and women combined, the lowest mean BMI reported was 22.1 kg/m^2 in South Asians [71], whereas the highest mean was reported in Filipino adults (26.8 kg/m^2) [46]. Among men, the lowest mean BMI was reported among young, Asian Indian men (22.8 kg/m^2) [54]; the highest mean was 25.9 kg/m^2 among Asian Indian immigrants to the San Francisco area [72, 73] and 25.7 kg/m^2 among Filipino men from Guam [48]. Among women, the lowest mean BMI was reported in Chinese community college students (19.4 kg/m^2) [6], and the highest mean was among Korean elderly women age 65 and greater (26.3 kg/m^2) [74].

According to NHIS data, which included Asian Indian, Chinese, and Filipino Asian subgroups, the highest proportions of overweight (23.0 ≤ BMI ≤ 27.4 kg/m^2) and obesity (BMI ≥ 27.5 kg/m^2) adjusted for age and sex were among Filipinos (46.5% overweight, 20.8% obese) and Asian Indians (46.7% overweight, 16.6% obese) [5]. Across all other studies combining men and women, the highest percent overweight (BMI 23-27.4 kg/m^2) was reported among Koreans (38.4%) [60] and the highest percent obesity (defined as BMI ≥ 25 kg/m^2) was reported among Filipinos (59%) [4]. Among studies reporting on both men and women, the lowest rate of overweight (25≤BMI≤29.9 kg/m^2) was among Asian Indians (12.8%) [75] and the lowest rate of obesity (BMI ≥ 30 kg/m^2) was reported for Vietnamese (2.1%) [58].

The prevalence of diabetes varied widely across articles. The lowest prevalence of diabetes was reported in South Asians (1%) [68], Chinese (3.96%) [64], and Vietnamese (5.3%, age-standardized) [58]. Reports for the greatest percent of diabetes included those for Filipinos (e.g., 36.4%, women in the Filipino Women's Health Study [42]) and Chinese (28%, 45 years or older with at least one CVD risk factor [4]). According to NHIS results, percent diabetes increased in overweight and even more in obesity across ethnicities studied. Comparing Asian subgroups (i.e., Asian Indian, Chinese, and Filipino) in a pooled NHIS analysis from 1997 to 2005, Asian Indians had the highest rates of diabetes in every category of BMI (age- and sex- standardized), compared to Chinese or Filipinos [5].

BMI, Overweight, Obesity, and Diabetes by specific Asian Subgroup

South Asians—Across the eight publications of South Asian samples, data were cross-sectional and unadjusted (Table 1). The mean BMI for analyses of men and women combined ranged from 22.1-25.8 kg/m^2 [71, 76, 77]. Other studies provided mean BMI of 22-25 kg/m^2 for males [69, 71, 78] and 22.3- 25 kg/m^2 for females [69, 78, 79]. Percent diabetes ranged from 1-11.6% [53, 68, 76]. Ivey and colleagues reported two studies (the California Health Interview Survey, CHIS, and the Cardiovascular Health Among Asian Indians Survey, CHAI) of South Asians in one publication [76]. CHIS recruited participants from a random-digit dial of households drawn from every county in California plus households from surname lists. Mean BMI was 24.5 kg/m^2, and 4% (n=37) reported diabetes. CHAI included South Asian adults from one of three areas within northern

California using list-driven, surname-based recruitment (n=252 telephone participants; n=52 in-person participants). Here, mean BMI was 25.6 kg/m^2 (telephone participants) and 25.8 kg/m^2 (in-person participants). Self-reported diabetes was 11% (n= 27) for telephone participants and 10% (n=5) for in-person participants. All other studies about South Asians used convenience samples. The largest of these studies examined South Asians living in Dallas; this study reported mean BMI at 24.9 kg/m^2 (n=616 participant without diabetes, mean age 42 years) [77]. In another study of South Asians aged 18-30 years, mean BMI (22.1 kg/ m^2) was similar to European Americans (23.7 kg/m^2); however South Asians had statistically higher ($p<0.05$) mean fasting blood glucose and family history of diabetes [71]. These findings are supported by another study among females with no history of diabetes, where mean fasting glucose was elevated (102.7 mg/dl) [79].

Asian Indians—All 20 articles identified for the Asian Indian subgroup were cross-sectional studies (Table 2). Oza-Frank, *et al.* 2009 [5] provided the largest sample of Asian Indians (n= 1357) with NHIS representing 1,234,233 individuals in the U.S.. The DIA study reported on 1038 Asian Indian adults (18 years and older) residing in seven U.S. urban sites [51]. While NHIS studies did not provide mean BMI, the DIA study reported a mean of 25.4 kg/m^2, adjusted for age and sex. In addition to the DIA study, eleven articles reported mean BMI for men and women combined with estimates ranging from 22.4 - 26.1 kg/m^2 [54, 61, 70, 72, 73, 75, 80-84]. The lower and upper values of this range were estimated by convenience samples, with the lower value among young, healthy volunteers (n=49) [54] and the upper value reported both among Asian Indians originally from the state of Gujarat living in Atlanta, Georgia (n=1046) [83] and among Asian Indian immigrants aged 29-59 in the San Francisco Bay area (n = 56) [72, 73]. Some articles stratified BMI by sex or studied only one gender, and the reported estimates for men and for women were similar, ranging from 22.8 to 25.9 kg/m^2 for men [51, 52, 54, 72, 73, 75, 82, 85-87] and 21.7 to 26.5 kg/m^2 for women [51, 52, 75, 82, 88].

Two articles reported the prevalence of overweight using Asian-specific cut-points. In NHIS, 46.7% (age- and sex- standardized) were overweight [5]. Misra, *et al.* 2010 reported 25% overweight among DIA participants (age- and sex- adjusted) [51]. The prevalence of overweight in men and women combined using other definitions for overweight ranged from 12.8-43.0% [7, 51, 70, 75, 80, 81, 89]. Three studies reported prevalence of obesity using WHO criteria for Asian populations; obesity prevalence in these studies ranged from 8% to 49.8% [5, 51, 61].

The prevalence of diabetes was reported in eleven articles (Table 2). In the DIA study, prevalence of diabetes for adults aged ≥20 was 17.4% (n=181), where 13.9% were known cases and 3.5% were previously undiagnosed (estimates age- and sex-adjusted) [51]. Stratifying by WHO Asian-specific BMI categories, NHIS diabetes estimates (age- and sex-standardized) were 6.5% among normal weight participants (BMI 18.5-22.9 kg/m^2); 8.3% among overweight participants (BMI 23.0-27.4 kg/m^2); and 19.4% among obese participants (BMI ≥ 27.5 kg/m^2) [5]. The lowest prevalence of diabetes was reported among a sample of 110 physicians and their adult family members aged 20 to 62 years (men: 6.6%; women: 8.9%; total: 7.5%) [52]. The largest reported prevalence of diabetes for men and

women (32.9%, age- and sex- standardized) was reported in NHIS among Asian Indians with BMI ≥ 30 kg/m^2 [5].

Chinese—More articles (n=44) presented information about the Chinese subgroup compared to any other Asian subgroup in this systematic review (Table 3). The only nationally representative samples identified in the systematic search for Chinese were NHIS samples [5, 7]. In the pooled (1997-2005) NHIS analysis, mean overweight was 38.2% (age- and sex-standardized), and mean obesity was 8.8% (age- and sex- standardized) as per WHO Asian-specific definitions [5]. This was the only study of Chinese Americans that used WHO definitions for overweight and obesity. In MESA, percent overweight (BMI 25-29.9 kg/m^2) was between 25-40% depending on age [13]. Furthermore, 4.5% were obese (BMI ≥ 30 kg/m^2) [10], an estimate similar to NHIS results when using non-Asian specific cut-points (NHIS 4.2%, age- and sex- standardized) [5]. In Hawaii, the Kidney Early Evaluation Program (KEEP-2) study contained 15% overweight and 47% obese volunteers as defined by the WHO International Obesity Task Force in 2000 (BMI≥23 kg/m^2 and BMI≥25 kg/m^2 respectively) [4].

Sex-specific estimates of percent overweight and obese were provided in a variety of ways across studies [3, 6, 34, 63, 90]. The highest estimates for overweight were from a subset of the New York City Chinese Health Study (NYC CHS), a population-based study of 55-75 year olds; the study reported 33% overweight (BMI = 25-29.9 kg/m^2) among men and 27.9% overweight among women [90]. This was the only study that reported prevalence of overweight for men alone. The lowest estimates for overweight among women were reported in the SWAN study; 17.0% of women in this study were overweight (25≤ BMI >30 kg/m^2) [34]. Only two estimates for percent obesity were found, and both were similar (3.5%, BMI ≥ 30 kg/m^2) and 3.6%, BMI >30.0) [3, 90]. In women, obesity ranged from 0.9% to 11% [3, 6, 26, 28, 30, 34, 90].

Mean BMI ranged from 23.3 kg/m^2 (Chinese participants aged 55-75 years subset from the NYC CHS) [90] to 25.8 kg/m^2 (U.S.-born Chinese aged 45-84 years at baseline from the MESA study) among men and women [15]. Among men only, mean BMI ranged from 23.2 kg/m^2 in elderly Chicago residents [3] to 24.1 kg/m^2 in MESA participants [13]. Among women, the lowest mean BMI (19.4 kg/m^2) was reported in a convenience sample of community college students [6] and the greatest (24.7 kg/m^2) in a convenience sample of postmenopausal women from New York City's Chinatown [91]. Mean BMI in SWAN was 22.5 - 23.4 kg/m^2 [3, 26, 27, 29, 31, 32, 35-37].

Diabetes prevalence estimates varied across studies. In a pooled NHIS analysis (1997-2005), 2.2% of normal weight Chinese (BMI 18.5-22.9 kg/m^2), 3.8% of overweight Chinese (BMI 23.0-27.4 kg/m^2), and 11.2% of obese Chinese (BMI ≥ 27.5 kg/m^2) had self-reported diabetes (all data age- and sex-standardized to the 2000 U.S. population) [5]. Those with BMI ≥ 30 kg/m^2 had 16.8% diabetes. Across all articles in the Chinese subgroup, the greatest prevalence diabetes was reported at 28% among Chinese participants in Hawaii, based on self-report or random, nonfasting blood glucose levels at 200 mg/dl or greater [4]. In MESA, 15.2% had diabetes based on a definition that included self-report, fasting glucose ≥ 126 mg/dl, or by use of hypoglycemic medication [9, 10].

Filipino—Among the 22 publications with Filipinos, all data were cross-sectional (Table 4). Seven publications reported population-based data from NHIS [5, 7], BRFS in Guam [47, 48], or the Kōhala Health Research Study/Native Hawaiian Health Research Project (NHHR) in rural North Kōhala, Hawaii [41, 45, 46]. In NHIS (1997-2005), 46.5% of individuals were overweight and 20.8% of individuals were obese (n = 1485, age- and sex-standardized) using WHO Asian specific definitions for overweight and obesity [5]. While data from NHIS 2003-2005 indicate that 13.2% of Filipinos were obese (BMI ≥ 30 kg/m^2) [7], pooled NHIS data from 1997 – 2005 show that 10.2% were obese [5], reflecting the increase in obesity over time. The lowest mean BMI among Filipinos was reported in Guam at 23.1 kg/m^2 (age-adjusted) for men and women combined, 25.7 kg/m^2 for men only, and 22.8 kg/m^2 for women only [47, 48]. Mean BMI among men and women from the NHHR project ranged from 26.0 kg/m^2 to 26.8 kg/m^2, with the latter estimate as the greatest estimate in the Filipino subgroup [41, 45, 46]. Among women, mean BMI was 21.7 kg/m^2 among community college students in Hawaii [6], between 24.3 kg/m^2 (age-adjusted) to 25.6 kg/m^2 among 40 to 86 year olds from San Diego county [38-44], 25.4 kg/m^2 (age-adjusted) among postmenopausal women in northern San Diego County [49, 50], and 26.0-26.8 kg/m^2 in the NHHR project [41, 45, 46]. Only one estimate was provided for men (mean BMI 25.7 kg/m^2) [48].

From 2003-2005, 6.1% Filipinos had diabetes in NHIS [7]. Pooled NHIS estimates of 1997 – 2005 diabetes prevalence (age- and sex- standardized) were as follows: 5.9% for normal weight (BMI 18.5-22.9 kg/m^2) Filipinos, 3.7% for overweight (BMI 23.0-27.4 kg/m^2), and 11.3% for obese (BMI ≥ 27.5 kg/m^2) [5]. Among Filipinos with BMI ≥ 30 kg/m^2,10.9% had diabetes [5]. Articles using other data sources estimated higher prevalence rates. In a study of men and women from five northern California Kaiser Permanente Medical Care Program centers, 21.2% had diabetes (age- and sex- adjusted) [2]. Across three publications on the NHHR project, 19.4-24.9% total diabetes prevalence was reported [41, 45, 46], with a higher prevalence (30.9%) among individuals 50 years and older [46]. Publications on the UCSD Filipino Women's Health Study reported 27.5 - 36.4% diabetes.

Korean—Two of the eight cross-sectional studies reporting on Koreans contained population-based samples (Table 5): the California Health Interview Survey (CHIS) randomly selected 492 Korean American adults, representing 330,000 Korean American adults in California in 2003 [60], and the Hypertension Screening Project for Korean Americans in Maryland (HSP) used a stratified sampling method to include 76 Korean Americans between 1998 and 1999 [66]. The CHIS study [60] reported percent overweight (defined by 2004 WHO definitions for Asians) as 38.4% for the entire sample, 49.0% among men, and 30.7% among women. Percent obese in the total sample was 7.5%, or 10.7% of men and 5.2% of women. The Multiethnic Cohort Study in Hawaii and Los Angeles reported that percent overweight or obese (BMI ≥ 25 kg/m^2) was 31.4% for U.S.-born women and 9.4% for Korea-born women [56]. Finally, another study of Korean elderly (age 60-95, n=90) in Chicago found 6.3% obesity in men and 5.0% obesity in women, defined as BMI ≥ 30 kg/m^2 [3]. BMI for Korean men ranged from 23.3 kg/m^2 for elderly men living in Chicago to 24.9 kg/m^2 among acculturated men in California [3, 92]. Reports of mean BMI

for women ranged from 22.1 kg/m^2 among Korean-born women and traditional Korean women [56, 92] to 26.3 kg/m^2 among elderly Koreans in Washington State [74].

Only two studies reported percent diabetes among Koreans in the U.S.. Among 497 Korean Americans residing in Michigan, 11% of men and 10% of women had self-reported diabetes (age-adjusted) [57]. Among elderly Koreans from Maryland, 22.7% of males and 15.4% of females had diabetes (fasting glucose ≥ 126 mg/dl) [65].

Vietnamese—Limited information was published for Vietnamese Americans (Table 6). A population sample from the Centers for Disease Control and Prevention (CDC) Racial and Ethnic Approaches to Community Health (REACH) 2010 program was collected, surveying Vietnamese residents of Santa Clara County, CA who were 18 years of age and older. Among Vietnamese, 17.3% were overweight (BMI ≥ 25.0 and <30 kg/m^2) and 2.1% (95% CI: 1.6, 2.7) were obese (BMI ≥ 30 kg/m^2) [58]. Among Vietnamese refugees who arrived to one Texas city and were screened, 12.3% were overweight (BMI ≥25 kg/m^2) [62]. Mean BMI was not reported. Two publications reported percent self-reported diabetes, ranging from 5.3% (age-standardized) to 15.6% (adjusted for age, sex, and education) [58, 93].

DISCUSSION

The purpose of this review was to systematically describe the state of overweight, obesity, and diabetes in specific Asian American subgroups. Our findings and key discussion points are summarized in Figure 4. Contrary to common approaches that generalize across Asians, the results of this review suggest that Asian American subgroups are vastly heterogeneous for these conditions, and generalizing them into one “Asian” group may be inappropriate. Also, despite the high volume of published reports on these conditions, this review reveals that representative studies are sorely lacking, exposing the inability to create summary estimates for specific Asian America subgroups, thereby prohibiting between-group comparisons of disease prevalence and risk factor associations. Among reported estimates for men and women, prevalence of overweight varied from 12.8 – 46.7% in Asian Indians, 15.0 – 38.2% in Chinese, and 15.0 – 46.5% in Filipinos; similarly, reports of obesity varied from 5.0 – 49.8% in Asian Indians, 2.4 – 47.0% in Chinese, and 8.6 – 59.0% in Filipinos. Only one or no estimate was provided for men and women in the other Asian subgroups. Reported prevalence of diabetes in samples of men and women ranged from 3.9 – 32.9% in Asian Indians, 1.0 - 11.3% in the South Asian category, 2.2 - 28% in Chinese, 3.7 – 30.9% in Filipinos, and 5.3 - 15.6% in Vietnamese, with one estimate for Koreans (18.1%).

A major finding of this review was that most studies about Asian American subgroups utilize designs that prohibit between-subgroup and within-subgroup comparisons. Many of the studies drew convenience samples from specific geographic regions, defined unique inclusion/exclusion criteria, and employed different definitions of overweight, obesity, and diabetes, limiting generalizability of data. In addition, studies did not always provide measures of overweight and obesity alongside measures of diabetes, making it difficult to study the relationship between overweight and diabetes. Approximately half of all articles were from seven studies: MESA, SWAN, Filipino Women's Health Study, HHR, BRFS in Guam, Rancho Bernardo Study, and NHIS, of which only NHIS was nationally

representative. For the 20% of all studies that accounted for confounding factors (i.e., age, sex) in their estimates, differing approaches were employed (e.g., age adjustment using study sample versus age-standardization to external population), also impacting comparability. Ultimately, these results provide conclusive evidence that standardized approaches to surveying Asian American subgroups are needed.

This systematic review has several limitations. All studies defined individuals based on country of origin rather than by genotypes of ethnicity, which could also play a role in prevalence differences. Additionally, the review covers a 20-year period that coincides with the rapid increases in the overall BMI among U.S. adults, making it difficult to distinguish overweight associated with ethnicity compared to overweight associated with the time period. Another limitation of this review is the ability to account for immigration and generation. First or second generation immigrants experience different obesity and disease rates compared to their ancestors [94]. Immigrants tend to have lower BMI upon migration, and foreign-born Asian Americans are significantly less overweight and obese than U.S.-born Asian Americans, though increased duration of residence in the U.S. is correlated with increased obesity [95-98]. Studies of Asian Americans by immigrant generational status also have observed a trend of increasing obesity and diabetes with later generations [99]. For example, the prevalence of diabetes is approximately 4 times higher among second-generation Japanese-Americans than among native Japanese [100].

Despite these limitations, the strengths of this review include the rigorous search for publications, which was systematic and thorough. With professional consultation in biomedical database searching and management from an experienced university librarian, the results of the PubMed search and the hand searches identified those publications which the authors expected to find based on their expertise in chronic disease epidemiology, medicine, and Asian American culture, attitudes, and beliefs. The searches also identified additional publications relevant to the review topic. In addition to the rigorous search, another strength is that the Asian American population is particularly well-suited to study differences in the relationship between overweight, obesity, and diabetes because the relationship in this population seems to be unique and may assist in unveiling underlying mechanisms of these health conditions [101]. Historically, data presenting the prevalence of diabetes, overweight, and obesity among Asian American populations have included them as a one collective group, but more recently, literature has emerged showing variations in diabetes and obesity risk when comparing specific Asian American subgroups to whites or blacks. Since 1960, the U.S. Asian population has increased almost fivefold, with more than 14 million Asians in the U.S. in 2009 and accounting for nearly 28% of the nation's foreign-born population [102]. Continued research on the heterogeneity in diabetes occurrence and risks among Asian Americans is necessary considering that this population is projected to comprise 9% of the total U.S. population by 2050 [103] and that the number of people living with diabetes is projected to increase from 366 million in 2011 to 552 million by 2030 [104]. It is of critical importance to study the relationship between ethnicity and chronic disease now, before extensive intermarriages between Asians and non-Asians makes it more difficult to identify and recruit specific Asian subgroups for studies.

Given the rapid recent and projected growth of the Asian American population, national surveys can improve surveillance and monitoring of this group through integration into existing systems [105] (i.e., BRFS, NHIS, NHANES) and through oversampling of Asian American subgroups. This would enhance national data and could be used to establish better prevalence estimates across Asian subgroups in the U.S. [106]. This includes Japanese Americans, a subgroup that was excluded from this study because Japanese migration to the U.S. occurred before the 20-year period of interest and Japanese Americans (1st, 2nd, and 3rd generation) have been extensively studied previously, unlike the Asian subgroups included in this review. In addition, large-scale population based analyses addressing more complex disease determinants of obesity and diabetes (beyond single gene polymorphisms) might improve the understanding of the relative impact of genetic and environmental factors linking them. Identifying the key risk factors and pathophysiolgical mechanism that lead to disease is essential to understanding the etiology of the disease and for the development of sound policies, including prevention and treatment strategies, for improved health among Asians.

In summary, this review summarized and synthesized data published in the past 20 years on the prevalence of diabetes, overweight, and obesity among Asian American sub-populations in the U.S. Although this review showed there are differences across Asian American subgroups, quantifying these differences is challenging because of the lack of nationally representative, standardized data *within* the Asian American group, a large, growing, and heterogeneous population. Future efforts to estimate levels of overweight, obesity, and diabetes must standardize approaches and include specific subgroups of Asian Americans to better understand and improve the health of these minorities in the United States.

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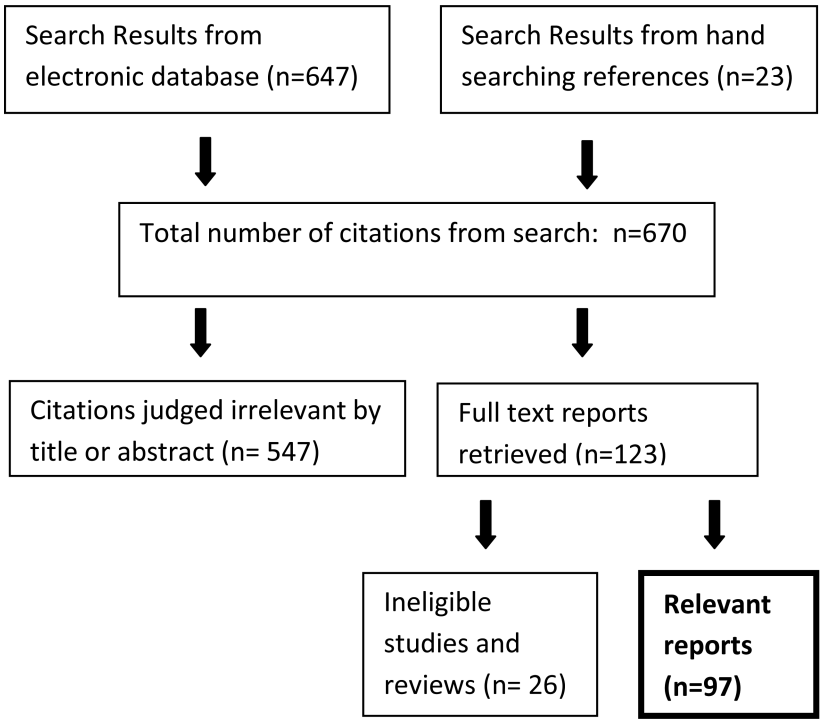

Figure 1. Systematic review flow chart: report selection

Studies were ineligible for the following reasons: BMI and percent overweight/obese and percent diabetes not provided (n=13); participant age (n=6); study dates (n=2); sample size (n=1); review paper (n=1); other (n=3)

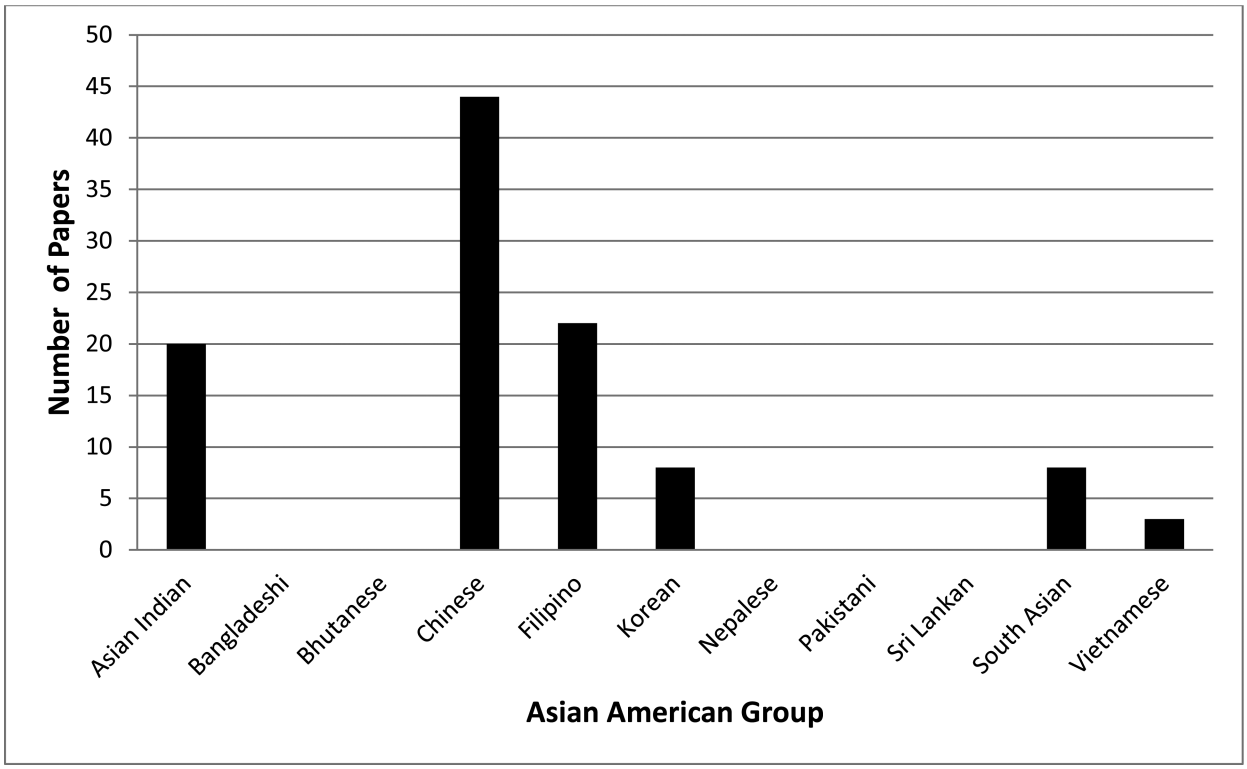

Figure 2. Number of publications reporting on Asian groups, 1988 – 2009,* by Asian American sub-population

*Reports with electronic publication in 2009 and paper publication in 2010 were included

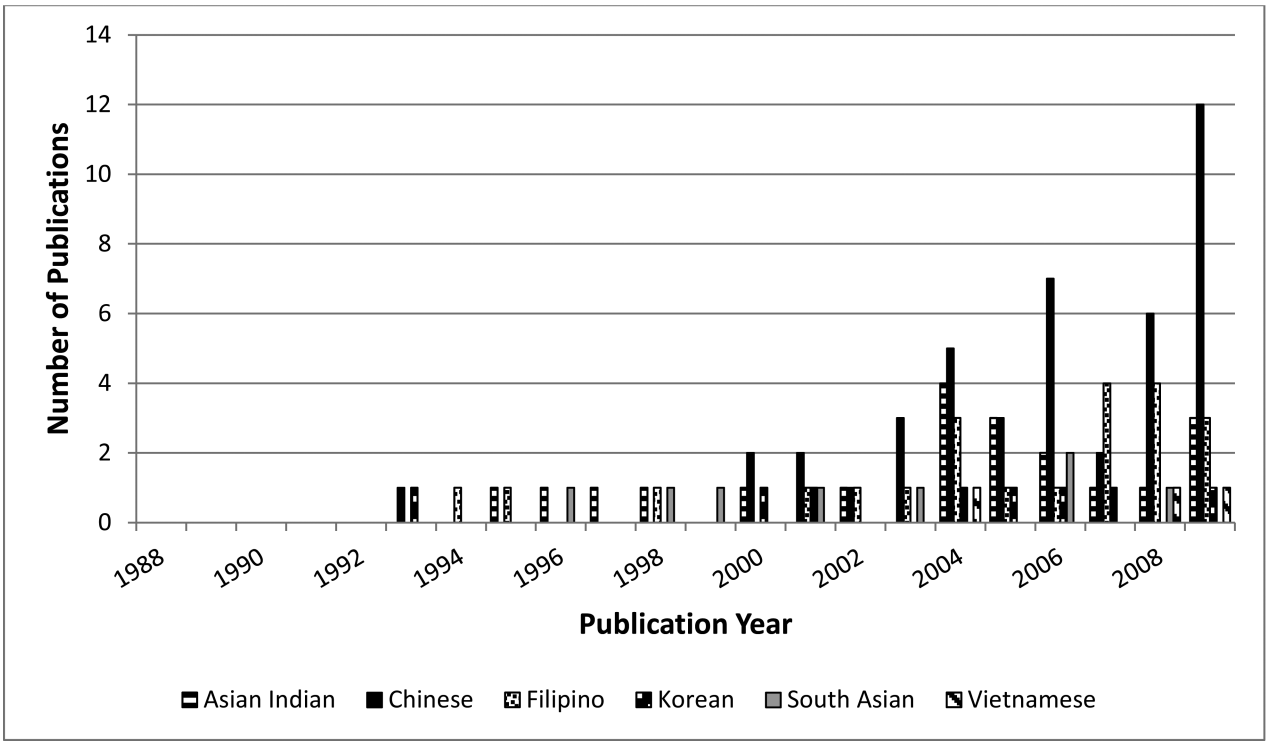

Figure 3. Number of peer-reviewed publications reporting data on specific Asian groups by year*

*Reports with electronic publication in 2009 and paper publication in 2010 were included.

- The purpose of this review was to describe the state of overweight, obesity, and diabetes in specific Asian American groups using peer-reviewed publications from 1988 - 2009.
- Data were only identified for Asian Indians, Chinese, Filipinos, Koreans, South Asians, and Vietnamese. No published reports were found for other studied Asian subgroups.
- Asian American subgroups are heterogeneous in the prevalence of overweight, obesity, and diabetes.
- Available studies on Asian American subgroups are not representative, limiting comparisons between the different subgroups.
- Available studies do not provide enough consistent information to create summary estimates for any one Asian American subgroup.
- Despite a generally held belief that all Asian Americans experience unique risk profiles for obesity, diabetes, and other diseases, inadequate data for various Asian America subgroups actually exists.
- Future research must adopt standardized approaches and provide representative estimates of specific Asian American subgroups to adequately understand and improve health among Asian Americans.

Figure 4.
Key Messages

Table 1

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: South Asian References (n=8)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Anand 1998 [68]	***[a]	141[a]	47[a]	***	***	***	1[a, c]
	Chicago, IL[b]	255[b]	46[b]	***	***	***	11.3[b, c]
Chandalia 2008 [69]	Dallas, TX	418 (men) 331 (women)	42 ± 15 (men) 42 ± 14 (women)	25 ± 15 (men) 25 ± 4 (women)	***	***	***
Chandalia 2003 [78]	Dallas, TX	82 (men)	31 ± 12 (men)	23.9 ±3.1 (men)	***	***	***
Enas 1996 [53]	***	1688 (total) 1131 (men) 557 (women)	46.4 ± 7.5 (men) 42.9 ± 7.4 (women) 48.0 ± 5.5 (men ≥ 40 years)	***	ob: BMI≥27.8	ob: 6.7 (men≥40 years)	7.6 (total)[d] 9.0(men)[d, e] 6.1(women)[d e]
Ivey 2006 [76]	CA counties / northern CA	769[f]	***	24.5 ± 5.5[f]	***	***	4[f g]
	CA counties / northern CA	257[b] 52[i]	***	25.6 ± 5.2[h] 25.8 ± 6.0[i]	***	***	11[h, g] 10[i, g]
Kalhan 2001 [71]	Cleveland area, OH	32	23.8 ± 2.0	22.1 ± 3.0	***	***	***
Kamath 1999 [79]	Chicago, IL	47 (women)	27.5 ± 5.6 (women)	22.6 ± 3.2 (women)	***	***	***
Radha 2006 [77]	Dallas, TX	616[j]	42 ± 13[j]	24.9 ± 3.7[j]	***	***	***

*** data not included or specified

[a] The first of two studies reported in Anand 1998 of the Coronary Artery Disease in Asian Indians (CADI) study

[b] The second of two studies reported in Anand 1998

[c] Estimate method not specified

[d] Based on previous diagnosis or use of insulin or oral hypoglycaemic agents

[e] Adjusted for age

[f] The first of two studies reported in Ivey 2006, the California Health Interview Study (CHIS) which used population-based random sampling

[g] Based on self-report

[h]The second of two studies reported in Ivey 2006, the phone portion of the Cardiovascular Health Among Asian Indians Survey (CHAI) which used population-based sampling

[i]The second of two studies reported in Ivey 2006, the in-person interview of the Cardiovascular Health Among Asian Indians Survey (CHAI) which used population-based sampling

[j]Portion of total sample without diabetes

Table 2

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: Asian Indian references (n=20)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Abate 2004 [85]	***	79 (men)	31 ± 12 (men)	24 ± 3 (men)	***	***	***
Abate 1995 [86]	***	93 (men)	47 ± 6 (men)	24.8 ± 3.1 (men)	***	***	***
Balasubramanyam 2008 [80]	Houston, TX	143	50.3 ± 13.8	25 ± 5.00	ov: 25<BMI<30 obi: BMI≥30 ob2: BMI≥25	ov: 31 ob1: 11 ob2: 43	18[a]
Bhalodkar 2005 [88]	***	119 (women)	47.9 ± 11.2 (women)	24.0 ± 4.7 (women)	***	***	***
Chuang 1998 [52]	***	110 (total) 64 (men) 46 (women)	45.9 ± 8.7 (men) 44.3 ± 8.6 (women)	24.0 ± 2.7 (men) 23.7 ± 3.1 (women)	***	***	7.5(total)[b] 6.6(men)[b] 8.9 (women)[b]
Ivey 2004 [84]	Northern CA cities	304	40	25.7	ov & ob: BMI>25[c]	ov & ob: 46.4	10.6[b]
Jonnalagadda 2007 [82]	Canton, MI	101 (total) 44 (men) 57 (women)	53 ± 13 (men) 55 ± 11 (women)	25.5 (total) 25.1 ± 3.1 (men) 25.8 ± 4.4 (women)	***	***	***
Jonnalagadda 2005 [81]	Metropolitan Atlanta, GA	226	58 ± 6	24.9 ± 3.3	ov: 25≤BMI≤29.9 ob: BMI>30	ov: 35 ob: 5	18[b]
Jonnalagadda 2002 [89]	Metropolitan Atlanta, GA	237	***	***	ov & ob: BMI>25[c]	ov & ob: 43	***
Kamath 1997 [87]	***	187 (men)	46 ± 9.3 (men)	23.6 (men)	ov: 26≤BMI≤30 ob: BMI>30	ov: 24 (men) ob: 2.2 (men)	8.8 (men)[b]
Misra 2010 [51]	7 suburba sites in United States	1038 (total)[d] 609 (men) 429 (women)	45.7 ± 1 2.8 (total)	25.4 ± 3.7 (total) 25.3 ± 3.3 (men) 25.6 ± 4.4 (women)	ov1: 25<BMI <30 ov2: 23.0≤BMI≤27.4 obi: BMI≥30 ob2: BMI≥27.5	ov1: 38 (total) ov2: 25 (total) ob1: 11 (total) ob2: 49.8 (total)	17.4 (total)[e] 20.0 (male)[e] 13.8 (female)[e] 14.0 (known)[e]
							3.4 (newly diagnosed)[e] 3.9 (among 20-39 years)[e] 17.1(among 40-59 years)[e]

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
							31.2(among ≥ 60 years) 60 years)[e]
Misra 2006 [73]	San Francisco Bay Area, CA	56 (total) 31 (men)	43.4 ± 6.9 (total) 43.7 ± 7.1 (men)	26.1 ± 3.7 (total) 25.9 ± 3.1 (men)	***	***	***
Misra 2005 [72]	San Francisco Bay Area, CA	56 (total) 31 (men)	43.4 ± 6.9 (total) 43.7 ± 7.1 (men)	26.1 ± 3.7 (total) 25.9 ± 3.1 (men)	***	***	***
Misra 2000 [75]	*** [f]	261 (total)	46.1 ± 7.4 (total)	24.0 (total) 24.3 (men) 23.3 (women)	ov: 25≤BMI≤29.9 ob: BMI>30	ov: 12.8 (total) ov: 14.2 (men) ov: 9.4 (women) ob: 7.4 (total) ob: 8.9 (men) ob: 4.1 (women)	***
Mooteri 2004 [70]	***	489[g]	49 ± 12	24.0 ± 3.5	ob: BMI>30	ob: 6	9[h]
Oza-Frank 2009 [5]	United States, 1997-2005 [i]	1357	37.6 (SE 0.4)	***	ovl: 23.0≤BMI≤27.4 ov2: 25.0≤BMI≤29.9 obl: BMI≥27.5 ob2: BMI≥30	ov1: 46.7, SE 1.8 ov2: 34.1, SE 1.6 ob1: 16.6, SE 1.4[j] ob2: 6.7, SE 0.9[j]	6.5, SE 1.9[b, j, k] 8.3, SE 1.7 (ov1)[b, j] 8.8, SE 1.8 (ov2)[b, j] 19.4, SE 3.5 (ob1)[b, j] 32.9, SE 4.4 (ob2)[b, j]
Petersen 2006 [54]	***	49 (total) 31 (men)	28.7 ± 8.3 (total) 30.0 ± 8.7 (men)	22.4 ± 2.3 (total) 22.8 ± 2.2 (men)	***	***	***
Venkataraman 2004 [83]	Atlanta, GA	1046	52.8 ± 11.3	26.1 ± 4.7	***	***	18.1[b]
Yagalla 1996 [61]	***	153	47.4 ± 6.4	24.6 ± 2.7	ob: BMI≥27.8	ob: 8	***
Ye 2009 [7]	United States, 2003-2005[i]	534	***	***	ob: BMI≥30	ob: 6.1	8.2[b]

*** Data not included or specified

[a] Based on fasting overnight blood glucose >100mg/dl - or - self diagnosed

[b] Based on self-report

[c] Reported as overweight in publication

[d] Sample from the Diabetes among Indian Americans (DIA) study. Directories for random sampling were created at each site through compilations of several sources. Five thousand were selected from this database (n=43,150)

[e] Diabetes diagnosed by fasting blood glucose ≥ 126 mg/dl or self-report of previously diagnosed diabetes

[f] Survey participants were invited from a directory of a national Gujarati Association in the United States

[g] Portion of total sample without coronary artery disease

[h] Estimate method not specified

[i] Participants from the National Health Interview Survey, a U.S. nationally representative survey of non-institutionalized adults (18 and older)

[j] Age and sex standardized to the 2000 U.S. population

[k] Among those with BMI 18.5-22.9 kg/m^2

Table 3

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: Chinese References (n=44)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Multi-Ethnic Study of Atherosclerosis							
Allison 2009 [9]	*a*	803	62.3 ± 10.3	24.0 ± 3.3	***	***	15.2[b]
Allison 2009 [8]	*a*	258	65 ± 10	24 ± 3	***	***	15[b]
Bahrami 2008 [10]	*a*	803	62.3 ± 10.3	24.0 ± 3.3	ob: BMI≥30	ob: 4.5	15.2[b]
Bertoni 2006 [11]	*a*	651	***	***	***	***	14.4[c]
Bild 2005 [12]	*a*	803	62.9 ± 10.3	24.0 ± 3.3	***	***	15.7[d]
Burke 2008 [13]	*a*	803	***	23.9 (women) 24.1 (men)	ov: 25.0≤BMI≤29.9 ob: BMI>30.0	ov: 33 (total)[e] ob: 5 (total)[e]	***
Colangelo 2009 [14]	*a*	388 (men)	***	***	***	***	15 (men)[b]
Diez Roux 2005 [15]	*a*	768 (non-U.S.-born)	62.3 (non-U.S.-born)	23.9 (non-U.S.-born)	***	***	14.3 (non-U.S.-born)[d]
Duprez 2009 [16]	*a*	374 (men) 395 (women)	62.3 ± 10.2 (men) 62.2 ± 10.4 (women)	24.0 ± 3.1 (men) 23.9 ± 3.5 (women)	***	***	16 (men)[b] 15 (women)[b]
Gao 2008 [17]	*a*	790	62.9	24.0	***	***	***
Kandula 2008 [18]	*a*	737	62.8 ± 10.2	23.9 ± 3.3	***	***	13.3[b]
Katz 2006 [19]	*a*	801 (total) 388 (men) 413 (women)	***	***	***	***	15.7 (total)[b, f] 16.5 (men)[v, f] 15.0 (women)[b, f]
Klein 2006 [20]	*a*	727	62.4 ± 10.2	24.1 ± 3.3	***	***	15.3[c]
Kramer 2004 [21]	*a*	803	62.9 ± 10.3	24.0 ± 3.3	***	***	14[c]
Ouyang 2009 [22]	*a*	272	65.6 ± 9.1	24.1 ± 3.7	***	***	18.4[b]
Palmas 2008 [23]	*a*	790	62.3 ± 10.3	23.9 ± 3.3	***	***	14.7[g]

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Paramsothy 2009 [24]	*a*	695	61.8 ± 10.4	23.8 ± 3.3	***	***	***
Wong 2006 [25]	*a*	724	61.8 ± 10.2	24.1 ± 3.3	***	***	14.5[b]
Study of Women's Health Across the Nation							
Everson-Rose, 2004 [27] [h]	Oakland, CA area	210 (women)	46.5 ± 2.6 (women)	23.2 ± 3.8 (women)	***	***	2.9 (incident diabetes, women)[i]
Gold, 2000 [28]	Oakland, CA area	546 (women)	***	***	ob: BMI≥27[j]	ob: 9.5 (women)	***
Greendale, 2003 [29]	Oakland, CA area	250 (women)	46.5 ± 2.6 (women)	23.3 ± 3.9 (women)	***	***	***
Habel, 2007 [30]	Oakland, CA area	179 (women)	***	***	ov: 24.2≤BMI≤28.2 ob:28.3≤BMI≤55.8[j]	ov: 23 (women) ob: 11 (women)	***
Kelley-Hedgepeth, 2008 [31]	Oakland, CA area	244 (women)	46.7 (women)	22.5 (women)	***	***	2.2 (women)[b]
Lasley, 2002 [32]	Oakland, CA area	228 (women)	46.43 ± 2.54 (women)	23.17 ± 3.94 (women)	***	***	***
Lo, 2006 [33] [h]	Oakland, CA area	151 (women)	***	***	***	***	3 (women)[b]
Matthews, 2005 [34]	Oakland, CA area	231 (women)	46.6 ± 2.6 (women)	23.2 ± 3.9 (women)	ov: 25≤ BMI<30 ob: BMI≥30	ov: 17.0 (women) ob: 4.4 (women)	***
Matthews, 2001 [26]	Oakland, CA area	562 (women)	***	22.90, SE 0.15 (women)	ob: BMI ≥ 30	ob: 3.56 (women)	***
Sowers, 2006 [36]	Oakland, CA area	151 (women)	46.0 ± 2.4 (women)	23.4 ± 4.2 (women)	***	***	***
Sowers, 2003 [35]	Oakland, CA area	220 (women)	47 ± 2.7 (women)	23.1 ± 3.9 (women)	***	***	***
Torrens, 2004 [37]	Oakland, CA area	210 (women)	46 ± 2.7 (women)	23.1 ± 3.8 (women)	***	***	***
National Health Interview Survey[j]							
Oza-Frank, 2009 [5]	United States, 1997-2005	1510	40.7 (SE 0.6)	***	ovl: 23.0≤BMI≤27.4 ov2: 25.0≤BMI≤29.9 obl: BMI≥27.5 ob2: BMI≥30	ov1: 38.2, SE 1.3[l] ov2: 20.6, SE 1.1[l] ob1: 8.8, SE 0.8[l] ob2: 4.2, SE 0.6[l]	2.2, SE 0.7 [l, m, n] 3.8, SE 0.8 (ov1)[l, m] 5.2, SE 1.5 (ov2)[l, m] 11.2, SE 3.2 (ob1)[l, m] 16.8, SE 4.3 (ob2)[l, m]
Ye, 2009 [7]	United States, 2003-2005	559	***	***	ob: BMI≥30	ob: 4.2	5.5[m]

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Other studies with Chinese participants							
Babbar, 2006 [91]	New York City, NY	300 (women)	63.0 ± 8.2 (women)	24.7 ± 4.0 (women)	***	***	***
Chen, 2009 [63]	San Francisco Bay Area, CA	65 (women)	***	23.1 ± 4.2 (women)	ov & ob: BMI>25[o]	ov & ob: 23.3 (women)	***
Cotler, 2009 [67]	Chicago, IL	2,457	55 ± 18	24 ± 4	ob: BMI>25	ob: 36	12[g]
Gomez, 2004 [2]	San Francisco, CA[p]	263 (total)	***	***	ov: 26≤BMI≤30 ob: BMI>30[j]	ov: 18.4[q] ob: 4.7[q]	6.4[m, q]
Hung, 2009 [64]	New York City, NY	2537 (total)	***	***	ov & ob: BMI>23[r]	ov & ob: 5.93, SE 0.61	3.96, SE 0.53[m]
Kim KK, 1993 [3]	Chicago, IL	169 (total) 59 (men) 110 (women)	74.6 (total)	23.2± 3.7 (men) 23.3± 3.9 (women)	ob: BMI>30.0	ob: 3.6 (men) ob: 4.7 (women)	***
Lauderdale, 2003 [108]	Chicago, IL	469	71	***	ov: 24.0≤BMI<26.5 ob: BMI≥26.5[j]	ov: 26 ob: 23	***
Maskarinec, 2001 [109]	Island of Oahu, HI	73 (women)	56.7 (women)	22.8 (women)	***	***	***
Maskarinec, 2000 [110]	Island of Oahu, HI	73 (women)	56.7 (women)	22.8 (women)	***	***	***
Mau, 2007 [4]	HI[s]	81	***	***	ov: 23≤BMI≤25[t] ob: BMI≥25	ov: 15 ob: 47	28[u]
Parikh, 2009 [90]	New York City, NY	517 (total)[v] 336 (men) 181 (women)	63.5, SE .38 (total) 64.3,SE .40 (men) 62.4,SE .61 (women)	23.3 (total) 23.5 (men) 23.1 (women)	ov: BMI 25.0-29.9 ob: BMI≥30	ov: 30.8 (total) ov: 33.0 (men) ov: 27.9 (women) ob: 2.4 (total) ob: 3.5 (men) ob: 0.9 (women)	***
Yates, 2004 [6]	HI	45 (women)	***	19.35 ± 3.51 (women)	ob: BMI>30	ob: 2 (women)	***

[k] U.S. nationally representative survey of non-institutionalized adults (18 and older)

*** Data not included or specified.

[a] Baltimore, MD; Chicago, IL; Forsythe County, N.C.; Los Angeles, CA; New York, NY; and St. Paul, MN

[b] Based fasting glucose ≥ 126 mg/dl, or use of hypoglycemic medication

[c] Based on self-report, fasting glucose ≥ 126 mg/dl, or use of hypoglycemic medication

[d] Based fasting glucose > 126 mg/dl, or use of hypoglycemic medication

[e] Estimates based on figure

[f] Percent diabetes calculated by reviewer

[g] Estimation method not specified

[h] Longitudinal analysis

[i] Based on self-report of diabetes treatment at any annual follow-up visit or based on a fasting glucose level of ≥ 126 mg/dl at the first and/or third follow-up

[j] Authors reported a distribution of BMI rather than overweight or obesity explicitly

[l] Age and sex standardized to the 2000 U.S. population

[m] Based on self-report

[n] Among those with BMI 18.5-22.9 kg/m^2

[o] Reported as overweight in the publication

[p] Hayward, Oakland, San Francisco, Santa Clara, and South San Francisco, CA

[q] Adjusted for age and sex

[r] Reported as BMI >23 kg/m^2 for overweight and BMI >25 kg/m^2 for obesity in the publication

[s] Hawaii site for the Kidney Early Evaluation Program (KEEP-2)

[t] Overweight was reported as BMI ≥23 in the publication with a prevalence of 15%

[u] Based on self-reported history or a random blood glucose value ≥ 200 mg/dl (nonfasting)

[v] Sample from New York City Chinese Health Study (NYC CHS), which used a complex multi-stage systematic stratified sampling design. May not be representative of frail elderly and the oldest old

Table 4

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: Filipino References (n=22)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
The University of California San Diego Filipino Women's Health Study							
Araneta 2007 [40]	San Diego area, CA	136 (women)	54.2 (women)	24.3 (women)[a]	***	***	***
Araneta 2006 [41][b]	San Diego, CA	446 (women)	57.6, 95% CI: 56.7, 58.5 (women)	25.4, 95% CI: 25.0, 25.8 (women)[a]	ob1: BMI≥25 ob2: BMI≥30	ob1: 49.2 (women)[a] ob2: 9.3 (women)[a]	31.6 (women)[a, c] 24.9 (women)[a, c]
Araneta 2005 [39]	San Diego area, CA	181 (women)	64.4 (women)	25.5 (women)[a]	***	***	32.1 (women)[c]
Araneta 2004 [38]	San Diego area, CA	181 (women)	64.4 ± 6.0 (women)	25.6 ± 3.4 (women)[a]	***	***	32.6 (women)[a, c]
Araneta 2002 [42]	San Diego area, CA	294 (women)	59.7 ± 5.2 (women)	25.6 ± 3.5 (women)	***	***	36.4 (women)[c]
Magno 2008 [43]	San Diego area, CA	211 (women)[d]	57.3, SE 0.68 (women)	25.1, SE0.23 (women)	***	***	27.5 (women)[c]
Wong 2008 [44]	San Diego area, CA	163 (women)	59.3 - 60 (women)[e]	25.1 - 26.3 (women))[e, a]	***	***	34.4 (women)[c]
Kohala Health Research Project / Native Hawaiian Health Research Project							
Araneta 2006 [41][b]	North Kohala, HI	109 (women)	57.9, 95% CI: 56.0, 59.8 (women)	26.0, 95% CI: 24.8, 26.5 (women)[a]	ob1: BMI≥25 ob2: BMI≥30	ob1: 50.5 (women)[a] ob2: 20.1 (women)[a]	24.9 (women)[a, c]
Grandinetti 2007 [45]	North Kohala, HI	186	53.7 ± 16.2	26.1 ± 5.8	***	***	19.35[f]
Kim 2008 [46]	North Kohala, HI	261	50.0 ± 16.3	26.8 ± 5.7	***	***	20.3[g] 30.9 [g] (among those with age ≥50 years) 8.3[g] (among those with age <50 years)
The University of California San Diego (UCSD) Rancho Bernardo Study							
Araneta 2010 [49]	San Diego, CA	152 (women)	59.5 (women)	25.4 (women)	***	***	33.6 (women)[c]
Morton 2003 [50]	San Diego, CA	285 (women)	59.9, 95% CI 59.3, 60.5 (women)	25.4, 95% CI: 24.0 - 25.9 (women)[a]	***	***	***

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Behavioral Risk Factor Survey (BRFS)[h] - Guam							
Pinhey 1995 [47]	Guam	342[i]	***[j]	23.09[a]	***	***	***
Pinhey 1994 [48]	Guam	115 (total) 49 (men) 66 (women)	48.1 ± 15.9 (men) 41.6 ± 12.6 (women)	25.7± 3.8 (men) 22.8± 4.4 (women)	ob: BMI ≥ 27	Ob: 21.2 (total)	***
National Health Interview Survey (NHIS)[k]							
Oza-Frank 2009 [5]	United States, 1997-2005	1485	41.2, SE 0.4	***	ovl: 23.0≤BMI≤27.4 ov2: 25.0≤BMI≤29.9 obl: BMI≥27.5 ob2: BMI≥30	ov1: 46.5, SE 1.7[l] ov2: 34.5, SE 1.4[l] ob1: 20.8, SE 1.3[l] ob2: 10.2, SE 1.0[l]	5.9, SE 3.7 [l, m n] 3.7, SE 0.7 (ov1)[l, m] 6.2, SE 1.1 (ov2)[l, m] 11.3, SE 2.0 (ob1)[l, m] 10.9, SE 3.0 (ob2)[l, m]
Ye 2009 [7]	United States, 2003-2005	633	***	***	ob: BMI≥ 30	Ob: 13.2	6.1[m]
Other studies with Filipino participants							
Cuasay 2001 [55]	Metropolitan Houston, TX	831	46.1 ± 12.0	24.6 ± 3.6	***	***	16.1. 95% CI: 13.5, 18.7 (total)[o, p] 13.1, 95% CI: 10.0, 16.2(women[p, q] 19.7, 95% CI: 15.1, 24.3(men)[p, q] 15.1, 95% CI: 12.4-17.8 (among BMI≤30)[p, q] 30.0, 95% CI: 16.6-43.4 (among BMI>30)[p, q]
Gomez 2004 [2]	San Francisco, CA[r]	268 (total)	***	***	ov: 26≤BMI≤30[s] ob: BMI > 30[s]	ov: 29.2 ob: 8.6	21.2 [m, t]
Guerrero 2008 [111]	Guam	61 (total) 33 (women)	***	25.9 (total) 24.4 ± 3.6 (women)	ov: 25.0≤BMI≤29.9 ob: BMI ≥ 30	ov: 30.3 (female) ob: 9.1 (female) ob: 20 (total)	***
Langenberg 2007 [112]	North San Diego, CA	389 (women)	58.7 ± 9.4 (women)	25.3, 95% CI: 24.9, 25.6 (women)	ob: not defined	ob: 9.8, 95% CI: 6.8, 12.7 (women)	31.4, 95% CI: 26.7, 36.0 (women)[c]
Mau 2007 [4]	HI[u]	134	***	***	ov: 23≤BMI≤25[v] ob: BMI≥25	ov: 15 ob: 59	20[w]

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Novotny 1998 [113]	HI	74 (women)	*** *x*	23.8 ± 4.5 (women)	***	***	***
Yates 2004 [6]	HI	59 (women)	***	21.71 ± 3.86 (women)	***	***	***

***Data not included or specified

[a]Adjusted for age

[b]Araneta 2006 provides separate estimates from two studies (in California and in Hawaii) and it is listed under two sections: The University of California San Diego Filipino Women's Health Study and the Kōhala Health Research Project / Native Hawaiian Health Research Project

[c]Based on 1999 World Health Organization criteria: fasting plasma glucose ≥ 126 mg/dl; 2-hour postchallenge glucose ≥ 200 mg/dL; history of type 2 diabetes diagnosed by a physician; or history of treatment with oral hypoglycemic agent or insulin

[d]Study reported additional data on 55 women with cardiovascular disease but these data are not included here due to exclusion criteria

[e]Mean age/BMI stratified by those with and without diabetes

[f]Based on 1998 WHO criteria for diabetes and abnormalities of glucose regulation

[g]Based on 1998 WHO criteria for diabetes: 2-hour plasma glucose 200 mg/dl; or fasting plasma glucose ≥ 126 mg/dl

[h]Survey representative of the non-institutionalized, adult (18 and older) population in Guam

[i]Portion of total sample without hypertension

[j]Aged 30 years and older

[k]U.S., nationally representative survey of non-institutionalized, adults (18 and older)

[l]Age and sex standardized to the 2000 U.S. population

[m]Based on self-report

[n]Among those with BMI 18.5-22.9 kg/m^2

[o]Unweighted, unadjusted prevalence

[p]Based on subjects' self-report. Presence of diabetes confirmed with questions on the questionnaire regarding the year and/or individuals age at diagnosis of diabetes, blood and OGTT, therapy used, frequency of blood tests, and doctors' visits

[q]Weighted prevalence

[r]Hayward, Oakland, San Francisco, Santa Clara, & South San Francisco, CA

[s] Authors reported a distribution of BMI rather than overweight or obesity explicitly

[t] Adjusted for age and sex

[u] Hawaii site for Kidney Early Evaluation Program (KEEP-2)

[v] Overweight was reported as BMI ≥ 23 in publication with a prevalence of 15%

[w] Based on prior history or a random blood glucose value ≥ 200mg/dL (non-fasting)

[x] Women were between 25 and 35 years of age, mean age not provided

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Table 5

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: Korean references (n=8)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Cho 2006 [60]	CA[a]	492	48.5	***	ov: BMI 23-27.4 ob: BMI ≥ 27.5	ov: 38.38, SE 2.95 (total) ov: 49.03, SE 4.99 (men) ov: 30.69, SE 3.82 (women) ob: 7.51, SE 1.36 (total) ob: 10.67, SE 2.82 (men) ob: 5.22, SE 1.31 (women)	***
Kim KK 1993 [3]	Chicago, IL	90 (total) 30 (men) 60 (women)	72.1 (total)	23.3 ± 4.5 (men) 24.2 ± 3.6 (women)	ob: BMI>30.0	ob: 6.3 (men) ob: 5.0 (women)	***
Kim, MT 2001 [65]	Baltimore, MD	205 (total) 75 (men) 130 (women)	69.9 ± 6.5 (total) 69.2 ± 5.9 (men) 69.9 ± 6.8 (women)	24.5± 3.5 (total) 24.3 ± 3.8 (men) 24.6± 3.3 (women)	ov & ob: BMI ≥ 25[b]	ov & ob: 43.3 (total) ov & ob: 45.3 (men) ov & ob: 42.3 (women)	18.1 (total)[c] 22.7 (men)[c] 15.4 (women)[c]
Kim, MT 2000 [66]	MD	761	50.5	***	ov & ob: BMI ≥ 25[b]	ov & ob: 28	***
Park 2005 [56]	Los Angeles, CA & HI	274 (U.S.-born) 218 (Korea-born)	62.5 ± 8.4 (women, U.S.-born) 53.5 ± 6.6 (women, Korea-born)	23.6 ± 4.1 (women, U.S.-born)[d] 22.1 ± 4.2 (women, Korea-born)[d]	ov or ob: BMI≥25	ov or ob:31.4 (women, U.S.-born)[d] ov or ob: 9.4 (women, Korea-born)[d]	***
Sin 2009 [74]	WA[e]	87 (total) 49 (men) 38 (women)	78 ± 6.58 (men) 73 ± 5.39 (women)	25.4 (total) 24.6 ± 2.44 (men) 26.3 ± 4.58 (women)	***	***	***
Song 2004 [92]	CA[f]	1026 (traditional males) 211 (bicultural males) 97 (acculturated males) 1220 (traditional females) 205 (bicultural females) 71 (acculturated females)	***	24.2,SE 0.1 (traditional males) 24.4, SE 0.2 (bicultural males) 24.9, SE 4.1 (acculturated males) 22.1, SE 0.1 (traditional female) 21.6, SE 0.2 (bicultural females) 21.3,SE0.4 (acculturated females)	***	***	***
Yang 2007 [57]	MI	263 (men) 234 (women)	53.8 ± 11.2 (men) 49.0 ± 11.0 (women)	24.0 ± 0.2 (men)[g] 22.4 ± 0.2 (women)[g]	***	***	11 (men)[g, h] 10 (women)[g, h]

*** Data not included or specified

[a]Data from the California Health Interview Survey, a statewide survey representative of non-institutionalized adults 18 and older

[b]Reported as overweight in this publication

[c]Based on 1997 National Diabetes Data Group's diagnostic criteria of fasting glucose ≥ 126 mg/dl

[d]Adjusted for age and education

[e]King County, Snohomish County, and Pierce County, WA

[f]Representative sample of Korean adults living in CA with telephones and Korean surnames

[g]Adjusted for age

[h]Based on self-report

Table 6

Results of a Systematic Review of Mean BMI, Percent Overweight (ov)/Obese (ob), and Prevalence of Diabetes in Asians: Vietnamese References (n=3)

Reference	City, State	Sample Size	Mean Age in Years ± SD	Mean BMI in kg/m^2 ± SD	Definition of ov, ob by BMI (kg/m^2)	Ov, ob, %	Diabetes, %
Barnes 2004 [62]	TX	114[a]	***	***	ov & ob: BMI ≥ 25[b]	ov & ob: 12.3	***
Nguyen 2009 [58]		4254[c]	18-34 years = 26.7%, 95% CI: 25.1, 28.3 35-54 years = 43.8% 95% CI: 42.2, 45.4 55+ years = 29.5% 95% CI: 28.0, 30.9	***	ov: 25.0 ≤ BMI < 30 ob: BMI ≥ 30	ov: 17.3, 95% CI: 16.0, 18.7[d] ob: 2.1, 95% CI: 1.6, 2.7[d]	5.3, 95% CI: 4.7, 6.0[d,e]
Sorkin 2008 [93]	CA	359[f]	64.6	***	***	***	15.6[e,g]

*** Data not included or specified

[a] Population-based survey of refugees in a city in TX

[b] Reported as overweight in publication

[c] From the CDC Racial and Ethnic Approaches to Community Health 2010 program

[d] Age-standardized

[e] Based on self-report

[f] Data from the California Health Interview Survey, a statewide survey representative of non-institutionalized adults 18 and older

[g] Adjusted for age, sex, and education