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Comparing Traditional Body Mass Index and Joslin Diabetes Center's Asian Body Mass Index in Predicting Self-Report Type 2 Diabetes

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Abstract

This study examined the predictability of traditional Body Mass Index standards and the Joslin Diabetes Center's recommended BMI standards for Asian Americans. A sample of 2973 adult Asian Americans aged 45 and older from the 2009 California Health Interview Survey (CHIS) was used. This sample consists of 12.25% of respondents with type 2 diabetes and 87.75% that had neither type 2 or any types of diabetes. Logistic regression was used to estimate the predictability of two the BMI standards and to test for the interaction effect of BMI standards and sex in predicting type 2 diabetes. The results revealed that both traditional and Joslin Diabetes Center's recommended standards had similar predictability of types 2 diabetes. Both BMI standards of overweight and obesity had a greater association with type 2 diabetes for men than for women. That is, given a similar level of BMI, men tend to report a greater prevalence of type 2 diabetes than women. These findings support caution in changing BMI cut-offs for Asian Americans, and highlight the potential limitations of using BMI as a measure of risk for diabetes in this population.

Keywords: Asian Americans, Body Mass Index, obesity, overweight, type 2 diabetes.

1. Introduction

1.1 BMI and Asian Americans

Type 2 Diabetes Mellitus is a serious chronic metabolic condition that can lead to debilitating health outcomes such as stroke, kidney failure, blindness, and limb amputations (Fowler, 2008). Increased access to foods and rapidly changing lifestyles has made type 2 diabetes a growing concern for many Asian Americans, with prevalence rates increasing from 4.7% to 7.3% between 1997 and 2008 as compared to 3.8-5.6% for Whites (Centers for Disease Control and Prevention, 2011; Karter et al., 2013; Lee, Brancati, & Yeh, 2011). There is strong evidence that early detection and management of risk factors can significantly reduce the incident of type 2 diabetes (Diabetes Prevention Program Research et al., 2009; Knowler et al., 2002).

Being overweight or obese is one of the main risk factors for type 2 diabetes (Kodama et al., 2014; Mokdad et al., 2003). In clinical and research settings, Body Mass Index (BMI) a measure of weight in kilograms (kg) adjusted for height in meters squared (m^2), has become the preferred surrogate measure of overweight and obesity due to its ease of use, cost, and utility in making relatively unbiased comparisons across short and tall populations (WHO, 1995). The BMI cut-points specified by the World Health Organization (WHO) are: 18.5 kg/m^2 and under (underweight); 18.5 to 24.9 kg/m^2 (normal weight); 25.0 to 29.9 kg/m^2 (overweight); and 30.00 kg/m^2 or greater (obese). These gradations, specifically the overweight and obese cut-off points, are associated with increasing rates of chronic diseases, including type 2 diabetes (WHO, 1995). As such, these standards are often used to inform policy as well as health prevention and disease management programs, and have been adopted by most countries including the US (Kuczmarski & Flegal, 2000).

In recent years however, there has been considerable debate about shifting BMI cut-off points for Asian populations both globally, and in the United States. These debates stem from studies that demonstrate a high prevalence of type 2

diabetes as well as other cardiovascular diseases among Asian samples despite mean BMI below 25 kg/m^2; the cut-off point corresponding to the overweight category (James, Chunming, & Inoue, 2002; Lee et al., 2011; Pan et al., 2004; Simmons, Williams, & Powell, 1991). In addition, there is increasing evidence of differences in body build, muscularity, and distribution of fat among Asians that has implications for the interpretation of BMI (Hsu et al., 2012). Notably, Asians generally have a higher percentage of body fat, concentrated around the abdomen, than white people of the same BMI, age, and gender- such that at a lower BMI, Asians have just as much fat than their White counterpart who may have a BMI that is 2-3 kg/m^2 lower (Deurenberg, Deurenberg-Yap, & Guricci, 2002).

In 2004, a WHO Expert Consultation Meeting was held to discuss recommendations for appropriate BMI cut-off points for Asian populations (WHO Expert Consultation, 2004). Despite evidence suggesting that Asians indeed have different associations between BMI and health risks than Whites, the WHO Expert Consultation concluded that there was insufficient data to justify redefining BMI cut-off points in different Asian populations. This decision was made in light of findings demonstrating that cut-offs for observed risk varies, between 22 kg/m^2 to 25 kg/m^2 (for overweight) and 26 kg/m^2 to 31 kg/m^2 (for obesity), in different Asian populations (WHO Expert Consultation, 2004). Creating ethnic specific cut-off points was thought to increase confusion in health promotion, and disease prevention or management programs. Additionally, lowering BMI cut-off points would substantially increase the prevalence of overweight and obesity within some Asian populations instantly, which may result in increased cost and burden on governments and organizations. Moreover, maintaining the cut-off points would promote a standardized approach for comparison across populations over time. Rather than redefining cut-off points, the WHO Expert Consultation provided public health "trigger points" for Asian populations, with 23 kg/m or higher representing increased risk, and 27.7 kg/m or higher representing high risk. Each country could then use these guidelines to make their own decisions of increased risk categories for their population. These recommendations and guidelines were made to ensure that current cut-off points could persist long-term, as well as allow flexibility for known changes in the association between BMI and co-morbidities within populations over time. For example, in 2000, a study of Asian Americans in the US reported low proportions of overweight and obesity (Lauderdale & Rathouz, 2000). However, with more American born Asians and longer length of stay in the United States, by 2011 the proportion of overweight and obesity increased to 29.8% and 9.3%, respectively (Schiller, Lucas, & Peregoy, 2012).

1.2 Purpose of the Study

In the United States, the Joslin Diabetes Center (http://aadi.joslin.org/content/bmi-calculator), a highly respected diabetes research and clinical care organization, has proposed the following cut-off points for South and East Asian Americans: 18.5 kg/m^2 and under (underweight); 18.5-23.9 kg/m^2 (normal weight); 24-26.9 kg/m^2 (overweight); $\geq$ 27.00 kg/m^2 (obese) (Wildman, Gu, Reynolds, Duan, & He, 2004). The main aim of this study was to determine if these cut-off points were better predictors of type 2 diabetes among Asian Americans than the traditional cut-off points, based on current population data. The secondary aim is to examine whether the association between BMI and type 2 diabetes is moderated by sex.

1.3 Hypotheses

In this study we proposed to test two hypotheses as follows:

Hypothesis 1. Both traditional BMI and Joslin Diabetes Center's Asian American BMI cut-off points have similar predictability of type 2 diabetes among Asian Americans.

Hypothesis 2. Both traditional BMI and Joslin Diabetes Center's Asian American BMI cut-off points have stronger predictability of type 2 diabetes for Asian American men than for Asian American women.

2. Methods

2.1 Data Sources

The California Health Interview Survey (CHIS) has been conducted every other year since 2001 and remains one of the largest population-based telephone health surveys in the nation. This study's sample came from the 2009 CHIS consisting of 47,614 Californian adults aged from 18 to 85. CHIS used a Random Digit Dialing (RDD) method to select and interview one adult aged 18 years or older in each randomly sampled household. In order to increase representatives of race ethnic subgroups, CHIS employed both disproportional stratified sampling and multiple frame sampling methods. CHIS captures a rich and diverse sample of individuals from different races, ethnicities and language backgrounds. Interviews were conducted in five languages: English, Spanish, Chinese (Mandarin and Cantonese dialects), Vietnamese, and Korean. Interviews in all languages were administered using Westat's computer-assisted telephone interviewing (CATI) system. The average length of an adult interview was 35 minutes. CHIS used both landline and cell-phone lists to select sampled households. In order to increase representatives of race ethnic subgroups, CHIS employed both disproportional stratified sampling and multiple frame sampling methods. A detailed description

and discussion of CHIS sampling methods can be found online posted on the CHIS website (http://healthpolicy.ucla.edu/chis/about/Pages/about.aspx). The overall response rates of CHIS have declined since the first survey was conducted in 2001 and they are now similar to those of other studies. The statewide response rate for adult interviews for the landline list sample was 49% and 56.2% for cell phone list sample. Our selected sample includes 2972 respondents aged 45 and older and who identified themselves as Asians. We selected respondents aged 45 and older because the majority of adults with type 2 diabetes are from this age group (Centers for Disease Control and Prevention, 2012). Approximately, 12% of this sample had type 2 diabetes as told by their doctor, and the remaining had neither type 2 nor any types of diabetes.

2.2 Measures

Traditional WHO BMI. The traditional BMI index was coded as under 18.5 kg/m^2 (Underweight); 18.5 to 24.9 kg/m^2 (Normal), 25.0 to 29.9 kg/m^2 (Overweight), and 30.0 kg/m^2 or greater (Obese). We collapsed these 4 categories into 2 categories: Overweight or Obese (1), and underweight or normal (0).

Joslin Diabetes Center's Asian BMI. As recommended by the Joslin Asian Diabetes Initiative (http://aadi.joslin.org/content/bmi-calculator), the BMI index was coded as: Below 18.5 kg/m^2 (Underweight), 18.5-23.9 kg/m^2 (Healthy Weight); 24-26.9 kg/m^2 (Overweight); above 27.00 (Obese). We also collapsed these 4 categories into two as we did for the NIH BMI index (http://aadi.joslin.org/content/bmi-calculator).

Types 2 Diabetes. This was a self-reported measure based on the question: "Were you told that you had Type 1 or Type 2 diabetes?" We coded 1 for Type 2 diabetes and 0 for no. Type 1 was excluded from the reference group.

Control Variables. We used 5 control variables including sex (coded 1 for female and 0 for male), marital status (coded 1 for married/partner and 0 for otherwise), education (coded 1 for college and higher and 0 for high school or lower), age (respondent's chronological age from 18 to 85), and annual family income (total dollars).

2.3 Data Analysis

We used logistic regression analysis to evaluate the predictability of the traditional BMI and Asian American BMI cut-off points in predicting self-report type 2 diabetes. The analysis included both simple logistic regression to estimate the unadjusted odds ratio of BMI's in predicting type 2 diabetes, and multiple logistic regression analysis to control for possible confounding effects.

3. Results

Table 1 presents the descriptive statistics of the variables used in the study's analysis. As presented in the table, 12.25% of Asian Americans aged 45 or older had type 2 diabetes, as told by their physicians. Based on the traditional BMI cut-off points, 32.94% were overweight or obese. This prevalence increased by almost 11% based on the Joslin Diabetes Center's Asian American BMI (43.64%).

Table 1. Descriptive Statistics of Variables Used in the Analysis

Variables	Asians (n = 2,972)
Type 2 Diabetes (% Had Type 2)	12.25%
Traditional BMI (% Overweight & Obese)[a]	32.94%
Joslin Diabetes Center's Asian BMI (% Overweight & Obese)[b]	43.64%
Sex (% Female)	56.59 %
Marital Status (% Married)	71.53%
Education (% High school or College)	67.43%
Age (Average age)	60.76
Income (Average Annual Family Income $)	64,451.62

[a]NIH BMI Index: Below 18.5 (Underweight); 18.5 – 24.9 (Normal) ; 25.0 – 29.9 (Overweight); 30.0 and Above (Obese).

[b]Joslin Asian BMI Index: Below 18.5 (Underweight); 18.5-23.9 (Healthy Weight); 24-26.9 (Overweight); 27.00(Obese).

Table 2. Predictability of Traditional BMI Index and Joslin Asian Diabetes Initiative Index in Predicting Self-Reported Type 2 Diabetes

Race/Ethnicity-BMI Index[a]	Unadjusted Odds Ratio (95% C.I.)	Adjusted Odds Ratio[b] (95% C.I.)
Asian Americans (n = 2972)		
Traditional BMI Index		
Overweigh/Obese	2.025***	1.975***
Reference: Underweight-Nornal	(1.622, 2.528)	(1.571, 2.482)
Joslin Diabetes CenterAsian BMI Index		
Overweigh/Obese	2.008***	1.948***
Reference: Underweight-Nornal	(1.607, 2.510)	(1.548, 2.452)

*** p = .001 [a]Adjusted for Sex, Marital Status, Age, Education, & Income

[b]Traditional BMI Index: Below 18.5 (Underweight); 18.5 – 24.9 (Normal) ; 25.0 – 29.9 (Overweight); 30.0 and Above (Obese).

[b]Joslin Diabetes Center's Asian BMI Index: Below 18.5 (Underweight); 18.5-23.9 (Healthy Weight); 24-26.9 (Overweight); => 27.00 (Obese).

Predictability of Traditional and Joslin Diabetes Center's BMI's. In Table 2, we present the unadjusted odds ratio and adjusted odds ratio of traditional BMI and Joslin Diabetes Center's Asian BMI. Overall, both BMI measures had a significant association with type 2 diabetes and this association remained statistically significance after we controlled for sex, age, marital status, education, and income. Surprisingly, both indexes of BMI had similar predictability of type 2 diabetes. For Asian Americans, those who had a traditional BMI index of 25 or greater had 1.975 (95% CI =1.571, 2.482) times the odds of having type 2 diabetes compared to those with a traditional BMI lower than 25. When the Joslin Diabetes Center's Asian's BMI was used, the odds of having type 2 diabetes among Asians with a BMI of 24 or greater were 1.948 (95% CI = 1.548, 2.452) as compared to those with a BMI of 23 or lower. As presented in Table 2, both unadjusted and adjusted odds ratios of traditional and Joslin Diabetes Center's Asian BMI measures had a similar association with type 2 diabetes among Asian Americans. Thus these two measures had similar predictability of type 2 diabetes. The results support our main hypothesis stated as: "Both traditional BMI and Joslin Diabetes Center's Asian American BMI cut-off points have similar predictability of type 2 diabetes among Asian Americans.

Interaction Effect on BMI and Sex. Table 3 presents the outcomes of tests for interaction effect between BMI and sex in predicting type 2 diabetes among Asian Americans. The results revealed that given a similar level of BMI, Asian American males had a greater probability of having type 2 diabetes than their female counterparts. More specifically, if the traditional BMI measure was used, overweight and obese Asian American men aged 45 or older had 6.4% greater probability of having type 2 diabetes than Asian women. Similar, when the Joslin Diabetes Center's Asian American BMI was used, Asian American men aged 45 or older had 5.9% greater probability of having type 2 diabetes than Asian women. Thus, the results in Table 3 support our secondary hypothesis stated as "Both traditional BMI and Joslin Diabetes Center's Asian American BMI cut-off points have stronger predictability of type 2 diabetes for Asian American men than for Asian American women."

4. Discussion

In general our results revealed no significant difference in the predictability of the traditional BMI and Joslin Asian's BMI cut-off points. Although the Joslin Asian's BMI cut-off points increased the risk of being overweight or obese for Asian Americans, it did not predict a greater likelihood of having type 2 diabetes than the traditional BMI cut-off points. This could have two implications. First, if the Joslin Asian's BMI was used, it could increase the diagnosis of overweight or obesity by almost 11% for Asians (see Table 1). While having an increased prevalence of overweight or obesity can help direct important and needed resources to address this problem, labeling individuals as overweight or obese unnecessarily can have serious unintended consequences. For example, in a survey of more than 3,000 adults aged 25-75, a strong inverse association was found between BMI and positive mood, self-acceptance, self-satisfaction, and perceived discrimination (Carr & Jaffe, 2012). Moreover, that study found that changes in one's weight at the lower bounds of the high BMI category (i.e. normal weight to overweight) had the most profound impact on one's psychological well-being (Carr & Jaffe, 2012). Second, given that lowering the criteria for overweight and obesity had no significant impact on the predictability of type 2 diabetes among Asian Americans in this sample, changing the BMI cut-off points to reflect what is currently recommended by the Joslin Center may contribute to undue confusion and challenges associated with comparing data across time and between groups. This sentiment was also noted in a recent systematic review of overweight, obesity, and diabetes among Asian Americans, where direct comparisons were limited due to a lack of standardization in methods used to measure overweight, obesity, and diabetes in the published literature (Staimez, Weber, Narayan, & Oza-Frank, 2013).

4.1 Limitations

This study has a few limitations. First, both BMI and type 2 diabetes were self-reported. Thus there is no mechanism to verify the accuracy of these measures. This is particularly important to recognize given that up to 30% of Asian American adults with diabetes are undiagnosed (King et al., 2012). As a result, the lack of validity and reliability of these measures could influence the accuracy of their association. Second, in this study, Asian Americans were aggregated onto one group. The authors acknowledge the heterogeneity in prevalence of type 2 diabetes across various Asian American ethnic subgroups (Acton et al., 2006; Karter et al., 2013). To limit this bias, the sample of Asian Americans in this analysis did not include Pacific Islander, a subgroup known to a have high prevalence of type two diabetes at higher BMI cut-offs, and for whom these lower BMI cut-offs were not meant for . Third, the data were collected in one geographical location, limiting the generalizability of the findings. Nevertheless, the CHIS data was systemically collected, and is representative of Asian Americans in California; one of the States in the US with the highest percentage of Asian Americans. Given the representativeness and scope of the data (n=2,972), our findings raise an important question concerning the advantage of using the Joslin Diabetes Center's Asian's BMI for Asian Americans.

5. Conclusions & Implications

Despite the strong and compelling case to use lower BMI thresholds to define overweight and obesity among Asian Americans , this analysis did not find that lower BMI cut-offs were more predictive of type 2 diabetes among Asian Americans than the traditional cut-off points. This is consistent with another large scale population study of 15,540 Chinese adults which found that BMI tertiles were not associated with diabetes (Wildman et al., 2005). These findings highlight the potential limitations of using BMI as a measure of risk for diabetes, and further support caution in changing the BMI cut-offs for Asian Americans. Nonetheless, as noted by Lauderdale and Rathouz (2000), the association between BMI and co-morbidities, such as diabetes, has changed within populations over time. Therefore, reexamining the utility of these lower BMI cut-offs overtime and in different geographic regions of the US with high population density of Asian Americans are warranted. Given the growing and urgent problem of type two diabetes among Asian Americans, additional efforts towards early detection of type 2 diabetes are needed. What has been suggested is the additional use of waist circumference, a better proxy measure for central adiposity, and a more sensitive predictor of type 2 diabetes and insulin resistance (Chan, Rimm, Colditz, Stampfer, & Willett, 1994; Palaniappan et al., 2004; Wang, Rimm, Stampfer, Willett, & Hu, 2005).

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