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Research Article

Obesity and Depression among Asian Indians in the United States: Findings from the MASALA Study

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Abstract

Background: Individuals of South-Asian origin have higher rates of abdominal obesity, and abdominal obesity plays an important role in cardio-metabolic disease even in the absence of elevated body mass index (BMI). Obesity is associated with depression, however the findings have been inconsistent. We aimed to determine the association between abdominal adiposity and depressive symptoms in a cohort of Asian Indians in U.S.

Methods: We conducted a cross-sectional study of 150 Asian Indians between ages 45-84 years in San Francisco Bay Area without pre-existing cardiovascular disease. Adiposity was assessed by anthropometric and radiographic measures including body mass index (BMI), waist circumference (WC), waist-to-hip circumference ratio (WHR), total lean mass and total fat mass from whole body dual X-ray absorptiometry, and visceral fat area by abdominal computed tomography. Depressive symptoms were assessed by 20-item Center for Epidemiologic Studies Depression Scale (CES-D). The odds for depressive symptoms were estimated using logistic regression analysis.

Results: Elevated WHR (O.R, 1.88; C.I: 1.04-3.40) was significantly associated with symptoms of depression and the association remained robust after adjustment for socio-demographic and various lifestyle factors.

Conclusions: Our findings suggest that irrespective of normal BMI, South Asians are more likely to have overall and regional obesity, which is associated with an increased risk of depression. Thus, mental health status should be evaluated in obese and overweight South Asian individuals. Further studies will help to clarify the causal relationship.

Keywords: Abdominal obesity; depressive symptoms; waist-to-hip circumference ratio; waist circumference; body mass index and CES-D.

Abbreviations: WHR: Waist-to-hip circumference ratio; WC: Waist circumference; BMI: Body mass index; L: SAR: liver-to-spleen attenuation ratio; CES-D: Center for Epidemiologic Studies Depression Scale; NHANES: National Health and Nutrition Examination Survey; MASALA: Metabolic syndrome and Atherosclerosis in South Asians Living in America.

Introduction

Obesity is one of the leading health problems in the world and in the U.S. in particular [1]. The most common method for diagnosing overweight and obesity is by using a surrogate measure of body mass index (BMI) [2]. However, BMI is an imperfect marker for total body fat and even less suitable to measure body fat distribution [2, 3]. BMI or waist circumference do not completely account for body composition [4, 5], whereas WHR (waist-to-hip circumference ratio) is a measure of body shape and to some extent lower trunk adiposity [2]. Studies have shown WHR is a good predictor for several non-communicable diseases [6-9].

Obesity has been associated with a higher prevalence of mental health disorders, such as anxiety, poor self esteem and in particular depression [10-12, 13], but the evidence is mixed since studies using only the BMI have produced inconsistent results [2, 14, 15]. Abdominal obesity has been associated with depression somewhat more consistently [16, 13, 17-19] and both obesity and depression has been associated with numerous chronic diseases like hypertension, coronary heart disease, myocardial infarction, low bone mineral density and increased mortality [20]. Among overweight and obese U.S. adults, abdominal obesity measured by waist circumference (WC) was significantly associated with an increased likelihood of having major or moderate-to-severe depressive symptoms. Thus, mental health status should be monitored and evaluated in adults with abdominal obesity [18].

A number of mechanisms have been suggested by which obesity could affect depression. Depression has been associated with visceral fat accumulation with increased adrenal volume as a potential explanatory factor [21, 22]. Increased production of stress hormone (cortisol) from hypothalamic-pituitary-adrenal axis (HPA) dysregulation involved in depression may contribute to body fat deposition [23]. Another explanation may be that recurrent episodes of binge eating may cause both weight gain and also negatively effect mood [24]. Poor self-rated health in obese and various social factors, like discrimination, maltreatment and stigma [25] may be other possible explanations for this association between obesity and depressive symptoms. Stunkard et al. reported that the association of obesity and depression was related to the degree of obesity in a graded fashion with gene-environment interactions having a role [26]. Thus the association between obesity and depression may be more pronounced in individuals with certain genetic backgrounds [20].

Asian Indians have higher abdominal/central obesity and high rates of cardio-metabolic disease even in the absence of elevated BMI as compared to other ethnicities [27]. At any given BMI, Asian Indians have more abdominal visceral fat, dyslipidemia, insulin resistance, diabetes, and hypertension [28, 29]. But no studies to date have examined the association between abdominal obesity and depression in Asian Indians. The purpose of this study was to examine the relationship of central adiposity and depressive symptoms in a community-based sample of Asian Indians in the United States.

Methods

We used data from a pilot community-based study called Metabolic syndrome and Atherosclerosis in South Asians Living in America (MASALA) conducted from 2006-2007 in the San Francisco Bay Area. Study methods have been described previously [27, 30]. A total of 150 participants were enrolled between August 2006 to October 2007. Our sampling frame was created using the South Asian surnames based on the California Health Interview Survey. We obtained name, address and telephone numbers using these surname lists from randomly sampled households from all nine counties of the San Francisco Bay Area. We mailed letters and conducted phone calls to assess study eligibility [30]. Briefly to be eligible, participants had to be between 45 and 84 years of age, self-identify as Asian Indian, and report no existing cardiovascular disease. We excluded those who had impaired cognition as judged by the reviewer, planed to move out of study region in the next year 5 years and those with life threatening illness like carcinoma or atrial fibrillation. We excluded individuals from other South Asian countries except for India due to the small sample size of this pilot study. Also, excluded were those who couldn't speak or understand English or Hindi [30].

Participant's demographic, metabolic, and body fat composition measurements were recorded. Informed consent was obtained at the clinical examination visit. The study was approved by IRB (Institutional Review Board) at the University of California, San Francisco.

Demographic and lifestyle variables

Participants completed face-to -face, interview administered questionnaires to ascertain age, sex/gender, medical history, smoking and alcohol use, and physical activity level which has been described in detail previously [30]. Briefly, total caloric intake over the previous year was assessed using the Study of Health Assessment and Risk in Ethnic Groups (SHARE) food frequency questionnaire, which was created and validated among South Asians in Canada [31]. Level of physical activity was assessed by Metabolic Equivalent of Task (MET)-minutes of exercise per week and that were assessed using the Typical Week's Physical Activity Questionnaire[32]. Overall, physical activity included intentional exercise, occupational activities, volunteer activities, household chores, yard-work, child/adult care, transportation, and leisure activities. Intentional exercise included walking for exercise, dancing, team sports, dual sports, individual activities, moderate conditioning activities, and heavy conditioning activities.

Body Fat composition measurements

Participant weight (in kg) was measured on a standard balance beam scale or a digital scale and height (in cm) was measured with a stadiometer and BMI was calculated as weight in kg divided by height in (meters)^2. Waist circumference was measured twice using a Gullick 2 tape at the point midway between lower ribs and anterior superior iliac spine and the mean of the measurements was calculated. Hip circumference was measured twice at the maximum circumference of the buttocks and an average of the two measurements was used. Waist-to-hip circumference ratio (WHR) was calculated. A trained research coordinator did all the anthropometric measurements.

Total lean and fat mass was assessed using dual-energy X-ray absorptiometry (Hologic Discovery-Wi; Waltham, MA, USA). Percent body fat was then determined using the measures of total lean and fat mass. Computed tomography (CT, Philips Medical Systems, Best, The Netherlands) was used to determine abdominal visceral and subcutaneous fat area. A trained radiology technician performed a non-contrast abdominal CT scan at the L4-L5 vertebrae level after participants were positioned supine. Visceral and subcutaneous abdominal fat were measured at the level of L4-L5 level after participants were positioned supine. A full body dual energy absorptiometry scan was performed and percent body fat was then determined using the measures of total lean and fat mass. All CT scans were digitally recorded for batched readings by a trained research assistant. Intra-abdominal adipose tissue area was quantified by delineating the intra-abdominal cavity at the innermost aspect of the abdominal and oblique muscle walls surrounding the cavity. Subcutaneous adipose tissue area was quantified by highlighting of adipose tissue located between the skin and the outermost aspect of the abdominal muscle wall.

We also obtained non-enhanced CT images of liver and spleen density to quantify hepatic fat content. CT measurements included minimal, maximal, and mean attenuation at a minimum of two liver sites and one spleen measurement. The presence of fatty liver was defined by a liver-to-spleen attenuation ratio (L:SAR) of < 1 and lower values represent higher amounts of hepatic fat [33-35].

Ascertainment of Outcomes

We administered a 20-item Center for Epidemiologic Studies Depression Scale (CES-D) questionnaire to assess depressive symptoms [36]. The CES-D measures depressive mood with a 20-item self-report scale that elicits symptoms of depression in community settings [36]. The participants were asked to rate how often over the past week they experienced symptoms associated with depression, like feeling of helplessness or hopelessness, sleeplessness, poor appetite. Response categories based on frequency of occurrence of symptoms, included: 0 = Rarely, 1 = Some or Little, 2 = Moderately, 3 = Almost all the time. Score can range from 0 to 60. A summed score of 16 or more has been defined as indicating high levels of depressed symptomatology on this scale [36]. Cronbach's alpha for reliability of the instrument has reportedly ranged between 0.85 and 0.90 in diverse populations [36]. While there is good reliability and validity of the scale in several clinic populations, and in different ethnic groups [37], this measure has not been formally validated in Asian Indians.

Statistical analysis

Comparison of baseline cohort characteristics by dichotomous CES-D scores (<16 vs. ≥16) was done using Pearson $\chi 2$ and Kruskal-Wallis tests as appropriate. Differences in sample medians were assessed using the Wilcoxon Rank Sum test.

The covariates used in this analyses were socio-demographic and lifestyle-related that, based on the existing literature and *a priori* hypothesis, could potentially confound association between obesity and depressive symptoms. We used logistic regression analyses to examine associations between adiposity variables and depressive symptoms after controlling for potential confounders: age, sex/gender, education (≤high school, ≤Bachelor's and >Bachelor's), family income (income levels ≤$40,000, $40,000-$74,999, $75,000-$99,999 and ≥$100,000), total energy intake and physical activity. All the adiposity variables were standardized in Stata 12 by using *egen* to allow for comparisons for their relative strength of association. This also led to re-express the adiposity variables as number of standard deviations above or below mean. We also checked for collinearity between various adiposity variables using Spearman's correlation test. Lastly, we checked whether sex modified the association between BMI and WHR and CES-D outcomes. All p-values obtained were two-sided with $p \leq 0.05$ considered as statistically significant. Statistical analyses were conducted using the STATA statistical software package (version 12; StataCorp LP, College Station, TX).

Results

Of the 150 Asian Indians enrolled in the MASALA pilot study, approximately 98% of participants were foreign-born and had lived in U.S. for an average of 27 ± 11 years. A total of 16 (11%) had depressive symptoms (CES-D ≥ 16). Table 1 shows the association between depressive symptoms and socio-demographic, lifestyle factors and adiposity variables. Overall, the mean age of our study participants was 57.2 years [SD (standard deviation) = 8.06]. Lower family income was associated with depressive symptoms with a similar trend seen for lower educational attainment. Depressive symptoms were also associated with no alcohol use.

Higher BMI and high waist circumference were marginally associated with depressive symptoms, but those with depressive symptoms had significantly larger WHR, but not higher, visceral or subcutaneous fat area.

Table 2 shows the odds ratios (OR) with 95% confidence interval (CI) for depressive symptoms with several standardized adiposity variables. After multivariate adjustment, WHR had significant association, the odds for depressive symptoms increased by 1.88 (95% CI: 1.04 - 3.40) per SD increase of WHR (p=0.04). The association for waist circumference (O.R, 1.62; C.I: 0.91- 2.89) and BMI (O.R, 1.17; C.I: 0.66 - 2.07) as-well as other adiposity variables were not statistically significant. Further, the association between the WHR and depression did not vary by sex.

Table 1: Baseline characteristics of MASALA study participants (2006-2007)*

Characteristics	No depression CES-D<16 N=134	Depressive symptoms CES-D≥16 N=16	*p*-value
Age (years), mean ± S.D	57.3 ± 7.9	56.3 ± 9.2	0.5
Sex, n (%)			
Male	68 (91)	7 (9)	0.6
Female	66 (88)	9 (12)	
Education, n (%)			
≤High School	26 (76)	8 (24)	0.02
≤Bachelor's degree	34 (92)	3 (8)	
>Bachelor's	74 (94)	5 (6)	
Family Income, n (%)			
≤$40,000	19 (83)	4 (17)	0.008
$40,000-74,999	21 (78)	6 (22)	
$75,000-99,999	18 (82)	4 (18)	
≥$100,000	76 (97)	2 (3)	
Marital status, n (%)			
Married	112 (89)	14 (11)	0.3
Widowed/divorced	20 (95)	1 (5)	
Never Married	2 (67)	1 (33)	
Lifestyle factors			
Alcohol intake, n (%)			
Non-drinkers	62 (83)	13 (17)	0.008
Drinkers	72 (96)	3 (4)	
Smoking status, n (%)			
Past/never	128 (89)	16 (11)	0.4
Current	6 (100)	-	
Total energy intake (kcal/day), median (Q1, Q3)	1881 (1463, 2360)	1565 (988,1811)	0.5
Physical activity (MET- min/ week), median (Q1, Q3)	1286 (683, 2498)	1291 (729, 2576)	0.6
Adiposity measures			
BMI (kg/m^2), mean ± S.D	26 ± 4.3	27 ± 7.2	
<25 kg/m^2	63 (89)	8 (11)	0.07
25-29.9	48 (96)	2 (4)	
>30	23 (79)	6 (21)	
Waist-hip circumference ratio (cm), mean ± S.D	0.94 ± 0.07	0.97 ± 0.07	
0.75-0.9	33 (94)	2 (6)	0.04
0.9-1.0	77 (92)	7 (8)	
1.0-1.12	24 (77)	7 (23)	
Abdominal visceral fat area, cm^2	133 ± 56	138 ± 60	0.5
Abdominal subcutaneous fat, cm^2	247 ± 100	291 ± 197	0.4
Waist circumference (cm), mean ± S.D	95.5 ± 11.38	101.8 ± 18.5	
<88	38 (88)	5 (12)	0.08
88-110	85 (92)	7 (8)	
>110	11 (73)	4 (27)	
Total lean mass, kg	42.9 ± 9.7	44.0 ± 9.9	0.7
Total body fat mass, kg	24.3 ± 7.6	26.9 ± 81.0	0.6
Liver to spleen attenuation ratio, HU	1.2 ± 0.2	1.2 ± 0.3	0.6
Psychotropic medication, n(%)			
Antidepressants not used	132 (90)	15 (10)	0.2
Use of antidepressants	2 (67)	1 (33)	

** data is presented as mean±SD or median with interquartile range (Q1,25th percentile; Q3,75th percentile) and n (row %) as appropriate; P-values are obtained using Chi-square, Kruskall- wallis test as appropriate.*

Abbreviation: MET, metabolic equivalent tasks; S.D, Standard deviation; HU, Hounsfield units.

Table 2: Covariate adjusted odds ratio between adiposity and depression in MASALA participants associated with regional and overall fat distribution.

Standardized adiposity variables	Odds ratio (95% CI)	p-value
Waist-to-hip ratio, per SD	1.88 (1.04 - 3.40)	0.04
Waist circumference, per SD cm	1.62 (0.91- 2.89)	0.1
BMI, per SD kg/m^2	1.17 (0.66 -2.07)	0.6
Abdominal Visceral fat area, per SD cm^2	1.38 (0.70 - 2.71)	0.4
Abdominal subcutaneous fat area, per SD cm^2	1.36 (0.77 - 2.41)	0.3
Total body fat mass, per SD kg	1.43 (0.79 - 2.60)	0.2
Total lean mass, per SD kg	2.30 (0.77- 6.89)	0.1
Liver to spleen attenuation, HU	0.75 (0.38 - 1.47)	0.4

**Each model is adjusted for age, sex, education, family income, physical activity, and total energy intake.*

**CES-D: Center for epidemiologic studies Depression Scale*

**HU: Hounsfield unit*

Discussion

In this small community-based sample of Asian Indians, higher WHR was independently associated with higher odds of depressive symptoms while no significant association was found between waist circumference and BMI and depression symptoms. This association between WHR and depression symptoms remained robust after adjusting for several socio-economic and lifestyle variables. The results suggest mental health status should be evaluated in Asian Indians with higher abdominal obesity and particularly with high waist-to-hip ratio.

Our results are consistent with studies in other ethnic groups that also looked at association between WHR and depression [2, 16, 38, 39]. This study suggests WHR is a better predictor of depression than BMI and WC and will help to design target interventions. High visceral fat, BMI and waist circumference have been associated with higher levels of depression in previous studies [18, 13, 40]. Obesity has been related to mental health issues in both White and Black women [41]. Hällström and Noppa studied women aged 38–54 years and found no association between obesity and mental illness [42]. After 6 years of follow up on the same group of women, investigators found a positive association between weight gain and depression but not with other mental health problems [10]. Another study from the National Health and Nutrition Examination Survey (NHANES I) found that greater body mass index was weakly related to elevated depression scores in women but not men [43]. In a study of Lassek and Gaulin [38], WHR was shown to predict cognitive ability and controlling for other correlates of cognitive ability resulted in mothers with low WHR and their children to have better cognitive test scores [38]. The relationship between depressive symptoms and waist-to-hip ratio as a component of metabolic syndrome has also been explored recently in a study examining the association of components of metabolic syndrome with depressive symptoms[39].

The present study has several strengths and limitations. Limitations include that in this cross-sectional study we cannot determine if higher WHR caused depressive symptoms. Previous studies have shown a bidirectional relationship between the adiposity and depression as depressed people are more likely to gain weight due to physical inactivity and other emotional problems [40, 44]. Moreover, this was a pilot study and our sample size was small. In order to make results generalizable in this population, we plan to test this hypothesis in a larger cohort of South Asians currently underway. However, this was a population-based sample of Asian Indians, a rapidly growing ethnic group in U.S [45] with higher risk of obesity-related diseases. To our knowledge, this is the first study to look at such an association in Asian Indians in US. Another asset of this study is that we had several radiographic measures of body composition besides, and comprehensive measures of obesity.

Conclusion

In summary, our finding of an association between central adiposity and depressive symptoms in Asian Indians underscores the need for providers to measure and address mental health issues in Asian Indians. Given the elevated risk of obesity-related chronic disease in this ethnic group, there is also a need to identify current health behaviors and psychosocial factors for illness in Asian Indians. Larger prospective studies of South Asians should examine whether measures of central obesity are associated with poor mental health outcomes.

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The authors indicated no potential conflicts of interest.

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