Physiology & Behavior 106 (2012) 651–656

Contents lists available at SciVerse ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/phb

Associations between weight-related eating behaviors and adiposity in postmenopausal Japanese American and white women

Susan M. Schembre [a,*], Cheryl L. Albright [b,c], Unhee Lim [d], Lynne R. Wilkens [d], Suzanne P. Murphy [d], Rachel Novotny [d,e], Thomas Ernst [f], Linda Chang [f], Laurence N. Kolonel [d], Loïc Le Marchand [d]

[a] Department of Preventive Medicine, Keck Medical Center of University of Southern California, USA
[b] Prevention and Control Program, University of Hawaii Cancer Center, USA
[c] School of Nursing and Dental Hygiene, University of Hawaii, USA
[d] Epidemiology Program, University of Hawaii Cancer Center, USA
[e] Department of Human Nutrition, Food, and Animal Sciences, University of Hawaii, USA
[f] Department of Medicine, John A. Burns School of Medicine, University of Hawaii, Honolulu, HI, USA

ARTICLE INFO

Article history:
Received 16 November 2011
Received in revised form 15 March 2012
Accepted 28 April 2012

Keywords:
Eating behaviors
Body fat distribution
Central obesity
Liver fat
Subcutaneous adipose tissue
Visceral fat

ABSTRACT

The purpose of this study was to test the associations between cognitive and psychological eating behavior traits and detailed measures of adiposity and body fat distribution using imaging-based methods in a cross-sectional study. Eating behavior traits (compensatory and routine restraint, external eating, and emotional eating) were assessed using the validated Weight-Related Eating Questionnaire, and measures of adiposity using anthropometry, dual energy X-ray absorptiometry (DXA), and magnetic resonance imaging (MRI). Each adiposity outcome of interest (total fat, ratio of trunk fat to periphery fat, visceral and subcutaneous fats as % of abdominal area, and % liver fat) was regressed on the four eating behaviors while adjusting for age and race/ethnicity. This study included a total of 60 postmenopausal Japanese American (n = 30) and white (n = 30) women (age: 60–65 years, BMI: 18.8–39.6 kg/m^2). Weight-related eating behavior traits did not differ by ethnicity. Higher external eating scores were associated with measures of total adiposity, including higher BMI ($\beta = 0.36$, $p = 0.02$) and DXA total fat mass ($\beta = 0.41$, $p = 0.001$), and with MRI abdominal subcutaneous fat ($\beta = 0.55$, $p = 0.001$). Higher routine restraint scores were associated with visceral adiposity ($\beta = 0.42$, $p = 0.04$). Our findings suggest that different weight-related eating behavior traits might increase not only total adiposity but also abdominal and visceral fat deposition associated with higher metabolic risks. Future research, preferably in a prospective study of men and women and including biomarkers related to psychological stress, will be needed to explore potential underlying biological mechanisms.

1. Introduction

Body fat deposition in the abdominal region is a known predictor of cardiovascular disease and diabetes [1], as well as some obesity-related cancers [2,3]. Compared to peripheral or subcutaneous abdominal adiposity, intra-abdominal visceral adiposity has a greater negative impact on health outcomes, with recent evidence suggesting several biological differences between subcutaneous and visceral abdominal adiposities [4]. While the tendency for some individuals to disproportionately store body fat in the abdomen might be influenced by race/ethnicity or genetic traits [5,6], there is a need to explore other, potentially modifiable, behavioral characteristics that contribute to elevated chronic disease and cancer risk related to increases in abdominal adiposity [4].

Much of the existing eating behavior research related to obesity has focused on identifying specific components of the diet (e.g., sugar sweetened beverages, dietary fat) and/or dietary patterns (e.g., breakfast skipping, fast food consumption) that might promote excessive weight gain [7–9]. Fewer studies have explored the role in obesity or central adiposity of cognitive and psychological aspects of eating behavior traits, which have been demonstrated to develop in childhood and persist through adulthood [10–14]. There are three theory-based constructs that describe these aspects of eating behavior. Dietary restraint [15], which reflects a rigid approach to weight control (routine restraint) as in chronic dieting, and a flexible approach to weight control (compensatory restraint), such as consciously eating more or less around times of overeating [16–18]. External eating [19] refers to the susceptibility to eat in response to the hedonic properties of food or other social/environmental influences. Emotional eating [20] reflects eating that occurs in response

* Corresponding author at: Department of Preventive Medicine, Keck Medical Center of University of Southern California, 2001 North Soto Street, Suite 312, Los Angeles, CA 90033, USA. Tel.: +1 323 442 7247; fax: +1 323 442 7254.
E-mail address: schembre@usc.edu (S.M. Schembre).

0031-9384/$ – see front matter © 2012 Elsevier Inc. All rights reserved.
doi:10.1016/j.physbeh.2012.04.027

to negative affect. These eating behaviors, particularly external and emotional eating, have been associated with high-fat, high-sugar patterns of dietary intake [21–23] related to higher levels of adiposity, and might contribute to explaining differences in body fat distribution [24].

To date, studies on eating behavior traits and obesity have been almost exclusively based on crude measures of adiposity (e.g., body mass index (BMI) and/or waist circumference) and, therefore, have limitations of potentially misclassifying total or abdominal adiposity. Furthermore, eating behaviors could influence body fat accumulation in the abdominal versus peripheral region or in the visceral versus subcutaneous compartment of the abdomen. For example, chronic dietary restraint, characterized by dieting and food avoidance has been associated with higher perceived stress, measured by higher levels of cortisol in saliva [25] or urine [26,27]. Also, increases in cortisol levels have also been positively associated with subsequent consumption of energy-dense foods [28–30] and fat deposition in the visceral compartment [31]. To our knowledge, only one prior study has examined the associations between eating behavior traits and image-based direct measures of abdominal and intra-abdominal fat distribution [24]. Provencher et al. [24], using the Three Factor Eating Questionnaire, demonstrated that flexible restraint had a negative correlation, and, rigid restraint and disinhibition, which encompasses external and emotional eating, and had a positive correlation with greater total, abdominal, and visceral and subcutaneous adiposities in the abdomen. These findings provided support that theory-based eating behaviors might contribute to explaining the distribution of total and abdominal adiposities.

The purpose of our study was to test the association of eating behaviors not only with total body fat but also with regional body fat distribution adjusted for total adiposity, using imaging-based methods of dual energy X-ray absorptiometry (DXA) and magnetic resonance imaging (MRI) scans. The analyses utilize data collected for a pilot study exploring the differences in adiposity and abdominal fat distribution between Asian American and white women. The study was conducted to investigate prior observations that Japanese American women showed higher risks for breast cancer [32] and diabetes [33] compared to white women at any given BMI level even after accounting for other risk factors. It was hypothesized that differences in body fat distribution might explain the heterogeneity in disease risk. Findings from the pilot study confirmed that Asian women have greater abdominal and visceral adiposities than white women with similar body mass indexes [34]. The sample size of 30 per group was selected as the minimum required to detect the large differences in fat distribution between Japanese and white women as expected based on preliminary data.

Based on previous literature, various eating behaviors are associated with both increased adiposity and biomarkers of acute and chronic psychological stress. It was, therefore, hypothesized that routine restraint, external eating and emotional eating would be associated with greater total adiposity, whereas compensatory restraint would be associated with lower total adiposity. We also hypothesized that routine restraint and emotional eating behaviors may be related to greater visceral as opposed to subcutaneous adiposity.

2. Participants and methods

2.1. Participants

White ($n = 30$) and Japanese American ($n = 30$) postmenopausal women living in Hawaii, aged 60–65 years were recruited from the ongoing Multiethnic Cohort Study. Details of recruitment and data collection methods are fully described elsewhere [34]. Briefly, recruitment was stratified by race/ethnicity and BMI categories based on self-reported weight and height. Exclusion criteria included: current or recent smoking (<2 years); use of medications that may interfere with metabolism and body composition (chemotherapy, insulin or weight-loss drugs); substantial weight change (loss or gain of 20 lb or more) in the past 6 months; pre- or perimenopausal status (had menses in the past 12 months); a measured BMI outside the target range (18.5–40 kg/m^2); and a report of any soft or metal implants/objects in the body that could bias the body composition estimates or put subjects at risk in the MRI's magnetic field. The study was approved by the Institutional Review Boards of the University of Hawaii and the Queen's Medical Center, Honolulu, and all participants signed an informed consent.

2.2. Body composition measures

As described in detail in the original publication [34], subjects fasted overnight for an early morning examination that included anthropometry measurements, DXA/MRI scans and fasting blood collection. All the participants wore a hospital gown for the anthropometry and DXA examinations, and comfortable shirts and pants without any metal parts for the MRI scan.

Anthropometric measures including height, weight, and waist circumference taken at the navel were collected using standardized protocols. Each measurement was taken twice, and a third time if the two measures differed by >0.1 kg for weight or by >0.5 cm for height or waist, after which the average of the two closest values was used in the analysis [34].

DXA was used to measure total and regional fat mass in the trunk, arms and legs. DXA measurements were completed by a certified radiographic technician using a whole-body DXA scan (GE Lunar Prodigy, Madison, WI, USA) [35]. Calibration using a manufacturer's phantom was performed daily. Measures of total and regional body fat mass in the trunk, arms, and legs were used to calculate trunk-to-periphery fat mass ratio (fat mass in the trunk divided by the sum of fat mass in the arms and legs).

Abdominal MRI scans were additionally conducted to determine the trunk fat distribution in visceral, subcutaneous and hepatic compartments, which cannot be attained directly using DXA. MRI scans were obtained at a separate appointment from 20 Japanese American and 28 white women among the 60 participants. Due to scheduling limitations, the time between DXA and MRI measurements were within one to thirteen weeks (median: 7.6 weeks). However, the body fat distributions based on DXA were found to be similar for women whose visits were close in time and those with visits spaced further apart. MRI was performed in a single session on a research-dedicated 3 T TIM Trio scanner (Siemens Medical Systems, Erlangen, Germany; software version VB13). Details of the MRI protocol have been reported [34]. The abdominal and peritoneal walls were manually traced to measure the total fat area (mm^2) and the visceral fat area (intraperitoneal, including fat inside internal organs), respectively, at the L4–L5 lumbar spine positions [34]. The visceral fat area was then subtracted from the total fat area to obtain the subcutaneous fat area (extraperitoneal). Percent liver fat was measured in a circular region of interest (15–25 cm^2) in the lateral portion of the right lobe of the liver [36].

2.3. Eating behaviors

Four theory-based, cognitive/psychological aspects of eating behavior labeled compensatory restraint, routine restraint, susceptibility to external cues, and emotional eating were assessed with the 16-item Weight-Related Eating Questionnaire (WREQ) [17], which has been validated as an online survey in a diverse sample of males and females confirming its unbiased generalizability across gender, age (young adults, 18–24 years and adults, 25–81 years), race (Japanese American and white women), and BMI subgroups (under/normal weight and overweight/obese) [37]. Routine restraint (3 items) and compensatory restraint (3 items) reflect two subscales of cognitive