Research Article

Clusters of Healthy and Unhealthy Eating Behaviors Are Associated With Body Mass Index Among Adults

William J. Heerman, MD, MPH[1,2,3]; Natalie Jackson, MPH[2,3]; Margaret Hargreaves, MD[4]; Shelagh A. Mulvaney, PhD[2,5,6]; David Schlundt, PhD[3]; Kenneth A. Wallston, PhD[5]; Russell L. Rothman, MD, MPP[2,3]

ABSTRACT

Objective: To identify eating styles from 6 eating behaviors and test their association with body mass index (BMI) among adults.

Design: Cross-sectional analysis of self-report survey data.

Setting: Twelve primary care and specialty clinics in 5 states.

Participants: Of 11,776 adult patients who consented to participate, 9,977 completed survey questions.

Variables Measured: Frequency of eating healthy food, frequency of eating unhealthy food, breakfast frequency, frequency of snacking, overall diet quality, and problem eating behaviors. The primary dependent variable was BMI, calculated from self-reported height and weight data.

Analysis: *k*-Means cluster analysis of eating behaviors was used to determine eating styles. A categorical variable representing each eating style cluster was entered in a multivariate linear regression predicting BMI, controlling for covariates.

Results: Four eating styles were identified and defined by healthy vs unhealthy diet patterns and engagement in problem eating behaviors. Each group had significantly higher average BMI than the healthy eating style: healthy with problem eating behaviors ($\beta = 1.9$; $P < .001$), unhealthy ($\beta = 2.5$; $P < .001$), and unhealthy with problem eating behaviors ($\beta = 5.1$; $P < .001$).

Conclusions and Implications: Future attempts to improve eating styles should address not only the consumption of healthy foods but also snacking behaviors and the emotional component of eating.

Key Words: obesity, body mass index, nutrition, behavioral science, eating patterns (*J Nutr Educ Behav*. 2017;■:1-7.)

Accepted February 5, 2017.

INTRODUCTION

Fighting obesity requires more than eating less and exercising more. Certainly caloric intake and physical activity frequency and intensity are the primary determinants of energy balance. However, both weight loss and maintenance of healthy weight are best achieved through sustained adherence to a broader range of healthy eating (eg, increased fruit/vegetable intake) and physical activity (eg, reduced sedentary time) behaviors. Based on a foundational understanding of the complex and multilevel determinants of healthy eating and healthy physical activity, much work has been done to develop interventions that facilitate these healthy behaviors.[1,2] In the US obesity affects 36.5% of adults and 17.0% of children.[3] With the long-term health complications of obesity, including diabetes, heart disease, and cancer, the continued effort to understand which eating behaviors support achieving a healthy weight is of paramount importance.[4,5]

Changes in eating behaviors have been independently associated with long-term changes in weight.[6] In particular, behaviors such as skipping meals, snacking, drinking sweetened beverages, and eating fast food were frequently studied as potential contributors to obesity.[7-9] Strong evidence links skipping breakfast with obesity, particularly among children.[10,11] However, a recent meta-analysis of 153 articles examining the association between eating

[1]General Pediatrics, Vanderbilt University Medical Center, Nashville, TN
[2]Department of Internal Medicine and Public Health, Vanderbilt University, Nashville, TN
[3]Center for Health Services Research, Vanderbilt University, Nashville, TN
[4]Department of Internal Medicine, Meharry Medical College, Nashville, TN
[5]School of Nursing, Vanderbilt University, Nashville, TN
[6]Department of Biomedical Informatics, Vanderbilt University, Nashville, TN

Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.

Address for correspondence: William J. Heerman, MD, MPH, General Pediatrics, Vanderbilt University Medical Center, 2146 Belcourt Ave, 2nd Fl, Nashville, TN 37212; Phone: (615) 322-7080; Fax: (615) 343-7650; E-mail: Bill.Heerman@vanderbilt.edu

http://dx.doi.org/10.1016/j.jneb.2017.02.001

behaviors and obesity among adults and children concluded that evidence was insufficient to draw meaningful conclusions owing to 2 major limitations.[12] First, most existing studies did not adequately consider potential confounders of the proposed associations. Second, most existing studies considered only how a single eating behavior was associated with obesity and did not account for the contribution of other potentially related eating behaviors.

Therefore, the objective of this study was to address the existing gap in the literature by considering how a broad range of eating behaviors relate to body mass index (BMI), controlling for potential confounders including sociodemographics (ie, age, gender, race/ethnicity) and physical activity in a large sample of adults. This was accomplished by first considering how 6 measures of diet quality and eating behaviors clustered together into patterns of eating styles, and then testing whether those eating styles were associated with BMI.

METHODS

Participants and Procedures

The researchers conducted analyses on cross-sectional survey data collected between August, 2014 and November, 2015. The primary mode of survey administration was via an electronic survey delivered on a tablet computer or an e-mailed survey link using REDCap.[13] Participants recruited in person also had the option to complete a paper survey. The survey consisted of 72 items that queried participants about demographic and background information as well as health behaviors, and took participants an average of 17 minutes to complete. This study received approval from the Vanderbilt University Institutional Review Board. All participants signed informed consent before participating and received a $10 gift card for completing the survey.

Patients were recruited from medical clinics in 3 health networks from the Patient Centered Outcomes Research Institute–funded Mid-South Clinical Data Research Network (CDRN).[14] The Mid-South CDRN integrates a clinical data infrastructure across the US, consisting of: (1) Vanderbilt University Medical Center partnering with Meharry Medical College, (2) the Vanderbilt Healthcare Affiliated Network, (3) Greenway Health, and (4) the Carolinas Collaborative, a consortium of 4 academic health systems and multiple community health systems across North Carolina and South Carolina. This study recruited participants from Vanderbilt, the Vanderbilt Healthcare Affiliated Network, and Greenway Health. The final sample of participants was recruited from 12 medical clinics, a mixture of primary care and subspecialty clinics. Recruitment occurred using 4 principal approaches: face-to-face recruitment in medical clinics, an e-mail sent directly from a patient's medical provider, an e-mail sent from the research team, or an e-mail sent from a clinic's medical director. To be eligible, participants: (1) were aged ≥18 years; (2) had ≥1 clinic note in the electronic health record (EHR) since April 30, 2009; (3) had ≥2 weight measures in the EHR since April 30, 2009; and (4) had ≥1 height measurement in the EHR after age 18 years. The survey was conducted exclusively in English. Participants were excluded if they had a mental condition or visual acuity that precluded participation (assessed by the research team at the time of face-to-face survey administration). Figure 1 shows a diagram of recruitment flow for the study.

Measures

The primary independent (predictor) variables consisted of 6 self-report eating behaviors: (1) frequency of eating healthy food (2 items); (2) frequency of eating unhealthy food (3 items); (3) breakfast frequency (1 item); (4) frequency of snacking (1 item); (5) overall diet quality (1 item); and (6) problem eating behaviors (4 items). A complete list of survey items included in this analysis and how they were scored is available in the Supplementary Material. The frequency of healthy and unhealthy food scores as well as the measure of problem eating behaviors were developed based on a factor analysis of 9 items from the survey, each of which was answered on a 4-point response scale from 1 = never to 4 = often; once a day or more. The healthy food variable was a composite frequency of eating fruits and vegetables (range, 2–8). The unhealthy food variable was a composite frequency of consuming fast food, sugary drinks, and desserts (range, 3–12). Self-reported frequencies of eating breakfast and snacking were scored on a 3-point response scale from 0 = never to 2 = daily. Self-reported diet quality was scored on a 5-point response scale from 1 = poor to 5 = excellent. These items were used in previous survey research and demonstrated validity in those contexts (ie, a prospective cohort of 3,000 hospitalized patients with acute coronary syndrome or heart failure[15]; and 67,928 participants enrolled in the Southern Community Cohort Study).[16] The 4-item measure of problem eating behaviors was based on a previously validated scale; in this study it had high internal consistency (Cronbach $\alpha = .83$).[17]

The primary dependent variable was BMI, calculated from self-reported height and weight data. Demographic variables were all self-reported and included age, gender, race/ethnicity, and household income. Self-reported physical activity was assessed as a potential confounder with a single item that ranged from 1 = I am very inactive to 5 = I am active most days.

Demographic characteristics including age, gender, household income, and race/ethnicity were summarized using mean and SD for continuous variables and proportions for categorical variables. Annual household income was categorized into 3 mutually exclusive categories (<$35,000, $35,000 to $75,000, and >$75,000). Race/ethnicity was categorized into 4 mutually exclusive categories (white, non-Hispanic; black, non-Hispanic; Hispanic; and other, non-Hispanic).

Analytic Strategy

k-Means cluster analysis was used for the 6 independent eating behavior variables to determine eating styles. A scree plot of the weighted sum of squares and the proportional reduction of the weighted sum of squares against a range of potential clusters (range, 1–20) was used to identify the optimal number of clusters necessary to prespecify in the *k*-means algorithm.[18] Based on the scree plot, 4 initial centroids were randomly identified and 10,000 repetitions of the *k*-means algorithm were conducted to achieve convergence of the solution