HHS Public Access

Author manuscript

Int J Obes (Lond). Author manuscript; available in PMC 2015 November 04.

Published in final edited form as:

Int J Obes (Lond). 2015 September ; 39(9): 1401–1407. doi:10.1038/ijo.2015.70.

Home environment and psychosocial predictors of obesity status among community-residing men and women

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Abstract

BACKGROUND/OBJECTIVES—Prior research indicates that features of the home environment (for example, televisions, exercise equipment) may be associated with obesity, but no prior study has examined objective features of the home food environment (for example, location of food) in combination with behavioral (for example, food purchasing), psychological (for example, self-efficacy) and social factors among obese adults. This study identified factors associated with obesity status from measures of home environment, food purchasing behavior, eating behavior and psychosocial functioning.

SUBJECTS/METHODS—One hundred community-residing obese (mean body mass index (BMI) = 36.8, s.e. = 0.60) and nonobese (mean BMI = 23.7, s.e. = 0.57) adults (mean age = 42.7, s.e. = 1.50; range = 20–78 years) completed an observational study with 2-h home interview/assessment and 2-week follow-up evaluation of food purchases and physical activity. Data were analyzed with analysis of variance and logistic regression, controlling for sex.

RESULTS—Univariate analyses revealed that homes of obese individuals had less healthy food available than homes of nonobese ($F(1,97) = 6.49$, $P = 0.012$), with food distributed across a greater number of highly visible locations ($F(1,96) = 6.20$, $P = 0.01$). Although there was no group difference in household income or size, obese individuals reported greater food insecurity ($F(1,97) = 9.70$, $P < 0.001$), more reliance on fast food ($F(1,97) = 7.63$, $P = 0.01$) and more long-term food storage capacity in number of refrigerators ($F(1,97) = 3.79$, $P = 0.05$) and freezers ($F(1,97) = 5.11$, $P = 0.03$). Obese individuals also reported greater depressive symptoms ($F(1,97) = 10.41$, $P = 0.002$) and lower ability to control eating in various situations ($F(1,97) = 20.62$, $P < 0.001$). Multiple logistic regression revealed that obesity status was associated with lower self-esteem (odds ratio (OR) 0.58, $P = 0.011$), less healthy food consumption (OR 0.94, $P = 0.048$) and more food available in the home (OR 1.04, $P = 0.036$).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONCLUSIONS—The overall pattern of results reflected that home food environment and psychosocial functioning of obese individuals differed in meaningful ways from that of nonobese individuals. In particular, lower self-esteem may be an important psychosocial aspect of obesity, especially in the context of greater food consumption and food storage/availability.

INTRODUCTION

Obesity continues to be a major public health problem primarily because of related rates of chronic illness (for example, diabetes, hypertension),[1,2] reduced quality of life,[3,4] limitations in physical functioning[5] and emotional distress.[6] Owing to the significant public health burden of obesity, it is critical to identify factors contributing to and maintaining obesity status. Past studies have documented environmental features associated with obesity, focusing primarily on characteristics of the school, work and community environments.[7] The home environment has been a focus of research in childhood obesity[8–10] and there is emerging evidence that smaller-scale factors associated with the home environment may be important targets of investigation in obesity research.[11–13] A recent study evaluated features of the home environment among normal weight and overweight adults, using both self-report and observer-coded measures of food, availability of exercise equipment and televisions, as well as self-reported physical activity (PA) and food intake.[14] Results indicated that overweight adults had less exercise equipment, more televisions and less healthy food options in the home. Similarly, in a sample of weight loss maintainers and treatment-seeking obese, Phelan and colleagues[12] found that weight loss maintainers had more exercise equipment, fewer televisions and less high-fat foods in the home environment, in addition to participating in more PA and reporting more dietary restraint and less dietary disinhibition.

The purpose of this study was to expand on prior work by conducting a more extensive evaluation of home environment features relevant to food, as well as eating-related behaviors, and psychological and social factors relevant to obesity. This study was designed to address a gap in the research literature by utilizing experimenter-assessed features and measurements in the home environment of obese individuals. Because psychological factors (for example, lower self-esteem, lower self-efficacy) also have been associated with obesity,[15,16] this study included relevant psychological factors that have not been included in prior examination of home environment features. It was hypothesized that obese adults in comparison with nonobese adults would have greater access to food, especially energy-dense food, *via* food purchases and food storage in the home environment. In addition, consistent with prior studies, it was hypothesized that psychosocial functioning would be lower among obese than among nonobese. The primary goal of the study was to identify the best predictors of obesity status from among relevant environmental and psychosocial variables.

MATERIALS AND METHODS

The Cholesterol, Health, Eating, Food, and Stress (CHEFS) at Home study used a cross-sectional design to examine the home environment of obese versus nonobese adults.

Participants

Participants were recruited from a large, metropolitan community primarily through ResearchMatch, a web-based registry of prospective research volunteers funded by the National Institutes of Health. Participants also were recruited from a university-specific research posting website, *via* flyers posted throughout the community, and by referral from other participants. Recruitment targeted obese adults (body mass index (BMI) ≥ 30) and nonobese adults (BMI < 30), with the two groups of participants matched as closely as possible on four demographic variables: sex, age (±2 years), race/ethnicity and years of education (±1 year). All but five of the participants were self-identified as the primary individual in the home responsible for food shopping and food preparation. Prospective participants were excluded because of self-reported health condition limiting mobility, mental health condition limiting daily function, current pregnancy (if female) or currently living in a dormitory (if college student). The study included a baseline home visit, a telephone follow-up 1 week after the home visit, and a mail-in follow-up 2 weeks after the home visit. Components of each assessment are described below.

Home visit—Two members of the research team completed each home visit, scheduled within 48 h of the participant's largest grocery shopping trip for the week (or month) to facilitate assessment of peak levels of food availability in the home and typical food purchases for the home. Home visits required 2–3 h, on average.

Anthropometrics

Height was measured with a portable stadiometer (Seca 214, Seca North America, Chino, CA, USA) and weight was measured with a digital high-capacity scale (Tanita Corporation, Arlington Heights, IL, USA). Waist circumference was measured at the iliac crest, and hip circumference was measured at the greatest protrusion of the gluteus from the participant's side. Body composition, fat mass and fat-free mass were calculated by measuring body resistance with a standard whole body tetrapolar bioimpedance analyzer (RJL Systems, Detroit, MI, USA), operating at a frequency of 50 kHz at 800 uA.

Cholesterol, triglycerides and glucose

Lipid data and glucose were collected following a 4-h fast *via* finger blood stick. Blood was analyzed with a Cholestech-LDX (Alere Inc., Waltham, MA, USA) cassette.

Twenty-four hour dietary recall

Participants were interviewed in detail regarding all foods consumed during the day prior to the assessment. The Nutrition Data Systems for Research software was then used to derive nutrient intake from the dietary data, and quality of dietary intake was rated using the Alternate Healthy Eating Index (AHEI)[17] to generate scores (range of 0–10 each, with higher scores reflecting greater consistency with Dietary Guidelines for Americans) for eight dietary components (fruits, vegetables, nuts and soy, ratio of white to red meat, cereal fiber, trans fat as a percent of total calories, ratio of polyunsaturated to saturated fat and alcohol; total score range 0–80).

Food frequency questionnaire (FFQ)

Food frequency questionnaire (FFQ) from the Health Habits and History Questionnaire (National Cancer Institute (NCI)) assessed typical intake of foods and nutrients by summarizing foods consumed and serving size estimates during the prior month. Dietary intake of energy, macro- and micronutrients was calculated using Dietary Analysis Software from NCI for the FFQ and Food Processor (ESHA, Salem, OR, USA, 1997).

Home food shelf inventory

An interviewer-administered food inventory was developed for this study from previously validated inventories[18,19] to provide a record of all common food items stored in the home, noting location of food in visible locations throughout the home as well as food in closed areas (for example, refrigerators, cabinets, closets). All foods listed in the shelf inventory were then grouped into categories (entrees, protein, fruits, vegetables, cereal, dairy, snacks, sweets, condiments, beverages and alcohol) for purposes of data analyses.

Food storage

All food storage in the home was recorded with digital photographs that were entered into a computer program (Canvas 12) for standardized measurement of the available storage area as well as the area filled with food. The proportion of space filled with food in all discrete spaces, such as cabinets, refrigerators, freezers and shelves, was then calculated within each photograph. Number of refrigerators and freezers in the home was recorded.

Exercise equipment and televisions

Participants identified all types of exercise equipment and the number of televisions in the home.

Home measurements

Participants identified up to three areas in the home where they preferred spending time and estimated distances (perceived distance) from each favorite area to all areas of food storage. In addition, actual distance in meters from favorite seating area to each food location was determined with a digital measuring wheel.

Food consumption

Participants reported areas in the home where they typically consumed meals and snacks. Total time spent eating, activities while eating and number of people typically eating with participants at each eating occasion was recorded.

Self-report questionnaires

Participants completed the following questionnaires:

1. Demographics and health: age, sex, marital status, family size, race/ethnicity, education, employment status, health history, current medication use, smoking and alcohol history.

2. Food-related activities: grocery store purchases, days since last grocery trip, frequency of eating meals outside the home, and meal-time behavior, measured with a modified Food Activities Questionnaire.[20]

3. Food insecurity measured with the U.S. Household Food Security Survey six-item short form.[21] Reliability of the measure in this sample was good (Cronbach's α = 0.86).

4. Psychological well-being was assessed with three scales reflecting domains previously associated with obesity:

   (a) Hospital Anxiety and Depression Scale (HADS)[22] is a 14-item measure incorporating a 7-item anxiety subscale (HADS-A) and a 7-item depression subscale (HADS-D), with each item rated on a 4-point Likert scale. In this sample, Cronbach's α for total scale = 0.84; anxiety α = 0.83; depression α = 0.73.

   (b) Eating Self-Efficacy Scale (ESE)[23] is a 25-item scale indicating degree of difficulty refraining from overeating in various situations. In addition to a total score, two subscores reflect eating due to negative affect and eating when it is socially acceptable. Mean scores for the total and the two subscores range from 1 (high self-efficacy) to 7 (low self-efficacy). Internal reliability was excellent (full scale Cronbach's α = 0.97; negative affect α = 0.97; social acceptability α = 0.93).

   (c) Medical Outcomes Survey Short Form 36 (SF-36)[24] measures quality of life in eight domains: physical functioning, social functioning, role limitations due to physical problems, role limitations due to emotional problems, pain, mental health, vitality and general health perception. In addition, two summary scores are generated: physical component score and mental component score. Only the mental health subscale was included in the psychological well-being domain (Cronbach's alpha = 0.82).

5. To assess perceptions of obesity-related effects on quality of life, subscales from two measures were included:

   (a) Impact of Weight on Quality of Life Questionnaire- Lite Version (IWQOL-Lite)[4] is a 31-item obesity-specific measure of health-related quality of life with each item rated on a 5-point likert scale. Higher scores reflect lower impact of weight on quality of life. Two subscales from this measure were included: self-esteem and sexual life (Cronbach's α self-esteem = 0.94; sexual life α = 0.93).

   (b) General health perception subscale (GHP) and the two component scores from the SF-36 measured quality of life (GHP Cronbach's α = 0.85; mental component score α = 0.93; physical component score α = 0.91).

6. Social support is a resource that may help buffer obesity-related stress. It was assessed with one scale and one subscale:

(a) Perceived Social Support Scale (PSSS)[25] is a 12-item measure with three subscales that assess support from family, friends and significant others. (Cronbach's α for full scale = 0.94; range of α for subscales:0.91–0.96).

(b) Social functioning subscale of the SF-36 measured ability to engage in social activities (Cronbach's α = 0.79).

7. Leisure health behavior may be affected by obesity, especially in the domains of sleep and PA. Thus, two measures were included to assess each area of functioning:

(a) Pittsburgh Sleep Quality Index (PSQI)[26] assesses sleep quality and disturbances over a 1-month interval, and provides a summary total score (Cronbach's α = 0.80).

(b) 7-Day Physical Activity Recall[27] is a measure of self-reported PA during the prior 7 days. Hours spent participating in moderate, hard and very hard PA were recorded, and total energy expenditure (kcal kg^{-1} per week) was calculated.

Receipts

Participants provided the most recent grocery shopping receipt during the home visit, and collected all food-related receipts during a 2-week interval following the home visit.

One-week follow-up—Telephone assessments were scheduled 1 week after the home visit to repeat the food shelf inventory, the 7-Day Physical Activity Recall, and the 24-h dietary recall.

Two-week follow-up—Participants continued collecting receipts for all food-related purchases during the week following the telephone assessment, and were provided a self-addressed, stamped envelope to mail materials to the research team.

Participants were compensated with a $20 Target gift card after the home visit. After completing all components of the study, participants received a $30 Target gift card and a summary of the anthropometric, cholesterol and glucose measurements recorded during the home visit.

Data analysis

Data were analyzed with *t*-tests, chi-square tests and analysis of variance comparing BMI groups (obese vs nonobese) across all dimensions: demographic and health variables; food visibility and storage in the home; food availability; psychological well-being and quality of life; social functioning; and leisure behavior. Within each domain of outcomes, logistic regression analyses were conducted predicting obesity status from groups of related predictor variables. Significant predictors from each of the primary logistic regressions were then combined in a single logistic regression to identify predictors of obesity status.

RESULTS

Consistent with recruitment criteria, obese participants had higher BMI, percent body fat and waist/hip ratio than nonobese participants, as shown in Table 1. Recruitment successfully resulted in two groups with equivalent health other than obesity and related body mass measurements. The two groups did not differ with regard to age, income, race, marital status, the number of additional people in the household or the mean age of household residents, as shown in Table 1. Among unmarried participants, nonobese participants were more likely than obese participants to have a roommate ($X^2(1) = 5.01$, $P = 0.025$). Consequently, food security and all food purchase and food availability variables were analyzed with roommate status (yes/no) as a covariate, as indicated below. Married participants in both groups were more likely than un-married participants to have children living with them, but the number of children did not differ across obesity groups ($X^2(1) = 1.81$, $P = 0.178$). The obese group was disproportionately female ($X^2(1) = 5.09$, $P = 0.024$) and individuals in that group were more likely to report currently attempting weight loss (AWL) ($X^2(1) = 26.6$, $P < 0.001$). Because sex was strongly associated with AWL ($X^2(1) = 9.54$, $P = 0.002$), only one of the two variables was included in each analysis as a covariate, to prevent multicollinearity violations in the regression analyses. All further univariate statistical analyses were conducted with sex as a covariate, and all logistic regression analyses were conducted twice, first with sex as a covariate and subsequently with AWL as a covariate.

When controlling for sex, obese participants had higher glucose levels and lower high-density lipoprotein cholesterol levels, as shown in Table 1. Food availability data, shown in Table 2, revealed that obese participants were more likely than nonobese to report food insecurity ($F(1,97) = 9.70$, $P < 0.001$), indicating more frequently reducing food intake owing to concern about running out of money or food. In the full sample, food insecurity was associated with lower self-reported income ($r = -0.39$, $P = 0.033$), and this effect was more pronounced in households with children present ($n = 77$; $r = -0.48$, $P < 0.001$), but food insecurity was not associated with the presence of children in the home *per se*. Food insecurity was associated with consuming a less healthy diet on the AHEI ($r = -0.22$, $P = 0.027$), specifically lower vegetable consumption ($r = -0.21$, $P = 0.038$), and with lower availability of alcoholic beverages ($r = -0.22$, $P = 0.025$) in the home. Among obese participants, food insecurity was associated with fewer sweets ($r = -0.28$, $P = 0.047$) and less alcohol ($r = -0.30$, $P = 0.033$) in the home. No other subscales from the AHEI or the food inventory were correlated with food insecurity. Overall, there was no difference between groups in the amount of money spent on food during the 2-week observation period, but obese participants spent more money on fast food ($F(1,97) = 6.39$, $P = 0.01$) and visited fast food restaurants more frequently ($F(1,97) = 7.63$, $P = 0.01$). These differences in fast food consumption remained statistically significant when controlling for the number of individuals in the household and when controlling for food insecurity. In addition, when analyses were conducted excluding the five non-primary shoppers, results for grocery and meal receipts did not change.

Food storage data indicated that obese and nonobese participants utilized equivalent proportions of the available storage space in household cabinets (obese = 51%; nonobese =

49%) and in refrigerators (obese = 58%; nonobese = 57%), but obese participants had more refrigerators ($F(1,97) = 3.79$, $P = 0.05$) and freezers ($F(1,97) = 5.11$, $P = 0.03$), as shown in Table 2. Measurement of observable food in the home (that is, food sitting on a surface either in the kitchen or elsewhere) indicated no difference in total amounts, but highly visible food (that is, food in plain sight of favorite locations in the home) was distributed across a greater number of locations in the homes of obese participants ($F(1,96) = 6.20$, $P = 0.01$), as shown in Table 2. Surprisingly, both the measured distance and the perceived distance from favorite home locations to food storage were significantly greater in obese participants than in nonobese. However, the shelf inventory data revealed that obese participants had more food items readily available than nonobese ($F(1,97) = 7.55$, $P = 0.007$). Specifically, obese individuals had more protein, entrees, sweets, snacks and condiments, as shown in Table 2, but there was no obesity group difference in the availability of cereal, fruits, vegetables, beverages, dairy products or alcohol. During the follow-up shelf inventory 1 week later, obese participants still had more protein ($F(1,97) = 15.49$, $P < 0.001$), entrees ($F(1,97) = 5.40$, $P = 0.022$), sweets ($F(1,97) = 6.78$, $P = 0.011$) and condiments ($F(1,97) = 8.19$, $P = 0.005$), as well as more beverages ($F(1,97) = 4.29$, $P = 0.041$).

Self-reported food consumption for the prior month (FFQ) indicated that overall intake of calories, carbohydrates and fats did not differ across the two groups, as shown in Table 3. However, the 24-h structured interview indicated that dietary intake of nonobese participants was more consistent with a ‘heart healthy’ diet than was dietary intake of obese participants ($F(1,97) = 20.97$, $P < 0.001$). Evaluation of dietary components indicated that nonobese individuals were eating larger amounts of designated healthy food groups (for example, fruit, vegetable, nut/soy, fiber, alcohol), as shown in Table 3.

HADS data indicated higher distress ($F(1,97) = 5.72$, $P = 0.019$) in obese participants, primarily in symptoms of depression ($F(1,97) = 10.41$, $P = 0.002$), but not anxiety, as shown in Table 4. Obese participants also indicated lower eating self-efficacy (that is, ability to control eating in response to emotions or in socially acceptable settings) than nonobese participants ($F(1,97) = 20.62$, $P < 0.001$), and poorer mental health on the SF-36 ($F(1,96) = 3.24$, $P = 0.014$).

Quality of life among obese participants was consistently lower than among nonobese as reflected by the general health perception subscale of the SF-36 ($F(1,96) = 10.56$, $P < 0.001$), as well as the physical component score ($F(1,94) = 4.15$, $P = 0.04$). Obese participants reported significantly greater weight-related impairments in quality of life in both self-esteem ($F(1,97) = 33.85$, $P < 0.001$) and sexual life ($F(1,95) = 9.37$, $P = 0.003$).

There were no obesity group differences in perceived social support overall, as shown in Table 4, but data from the SF-36 social functioning subscale indicated that obese participants experienced more barriers to enjoyment of social interactions with others ($F(1,96) = 5.57$, $P = 0.02$).

Sleep quality of obese participants was poorer than that of nonobese (PSQI, $F(1,97) = 7.83$, $P = 0.01$). Although overall self-reported energy expenditure *via* exercise activity was

equivalent across groups, obese participants reported spending significantly less time engaged in 'very hard' activities ($F(1,97) = 7.40$, $P = 0.01$), as shown in Table 4.

Regression analyses

Within each domain of outcome variables, logistic regression analyses were conducted predicting obesity status from variables that were statistically significant in analysis of covariances of group differences. A series of six logistic regressions was conducted, one for each group of conceptually related variables.

Regression of obesity status on the two significant health variables (glucose and high-density lipoprotein) revealed that neither was a significant predictor. The regression of food visibility and storage variables (that is, number of refrigerators, number of freezers, highly visible food locations, distance to food and perceived distance) revealed no significant predictors of obesity status. The regression of significant food availability variables (food insecurity, fast food costs, fast food visits, shelf inventory total score) revealed that food insecurity (odds ratio (OR) = 2.0, $P = 0.006$) and the shelf inventory (OR = 1.04, $P = 0.004$) were predictors of obesity status. Regression of significant psychological well-being variables (HADS-total, ESE-total and SF-36 mental health) revealed that ESE-total was a significant predictor of obesity group status (OR = 2.04, $P < 0.001$). A follow-up regression entering HADS-Depression in place of HADS-total and entering the two ESE subscales in place of the total score revealed that none of the subscales predicted obesity status. Regression of four quality-of-life variables (GHP and physical component score scales from SF-36, and two IWQOL subscales) indicated that the IWQOL self-esteem subscale predicted obesity group (OR = 0.73, $P < 0.001$). Regression of significant leisure behavior variables (that is, sleep quality as measured by PSQI and very hard PA from the 7-day Physical Activity Recall) revealed that both sleep quality (OR = 1.16, $P = 0.036$) and very hard PA (OR = 0.81, $P = 0.037$) remained significant predictors of obesity status. When each of the regressions was repeated with AWL as a covariate instead of sex, all predictors of obesity status remained the same.

Significant predictors of obesity status from each of the six logistic regressions of conceptually related variables were then entered together into a summary logistic regression, along with the social functioning subscale from the SF-36 and the AHEI total score, to identify the best predictors of obesity status from this subset of variables. Predictors in the regression included food insecurity, shelf inventory total, AHEI total, ESE total, IWQOL self-esteem, SF-36 social functioning subscale, PSQI and very hard PA. As shown in Table 5, obesity status was predicted by AHEI total (OR = 0.94, $P = 0.048$), shelf inventory total (OR = 1.04, $P = 0.036$) and IWQOL self-esteem (OR = 0.58, $P = 0.011$). When the final logistic regression was repeated substituting AWL as a covariate instead of sex, IWQOL self-esteem was no longer statistically significant, but AHEI total and shelf inventory total remained significant predictors.

DISCUSSION

The process of identifying predictors of obesity status and refining the predictive equations resulted in a set of obesity predictors reflecting larger amounts of food in the home

environment, consumption of less healthy food, and lower self-esteem (that is, feelings of insecurity and low self-esteem related to body weight). Although the study included an extensive evaluation of home environment features, only a portion of those features were found to discriminate between obese and nonobese participants, with the shelf inventory of food being the strongest predictor. However, additional food availability variables discriminated between obese and nonobese individuals in the univariate analyses. The greater degree of food insecurity among obese participants than among nonobese is consistent with prior data from a large sample of overweight women.[28] In addition to food insecurity, obese participants had larger amounts of calorie-dense food (for example, entrees, sweets and snacks) at home and greater capacity for storage of perishable foods (that is, more refrigerators and freezers), while also relying more on lower-cost fast food. Although there was no difference between obese and nonobese participants in the amount of observable food (that is, food in visible locations around the participant's home), it was striking that food visible from favorite locations was distributed across a greater number of locations (outside of the kitchen) in the homes of obese participants. Interestingly, distance from favorite locations in the home to all food sources was greater among obese participants than among nonobese participants. Thus, despite greater storage capacity for food, more calorie-dense food in the home and food more highly visible across more locations in the home, obese participants were more likely to report food insecurity and to rely on fast food for a greater proportion of meals. In the absence of group differences in income or household size, the differences in food storage and availability may underscore the importance of perceptions of food in the home environment, especially because obese participants indicated feeling less capable of restraining eating in response to emotions and in situations where eating would be socially acceptable.

Consistent with data from prior studies, obese participants reported greater levels of distress, especially depression, than nonobese participants.[29] Although the obese and nonobese groups reported equivalent levels of structural social support (that is, availability of support from others), obese participants reported less ability to engage in social functions. It is not clear from these data whether limited social activity reflects restricted mobility or reluctance to engage with others due to self-consciousness or perceived stigma, or perhaps other factors. Indeed, it is not possible to infer causality between any emotional or physical state and obesity status from this study because the data are cross-sectional. However, the results present a cohesive picture of obese individuals in this sample being more distressed than nonobese, having lower self-esteem, feeling less able to engage in social activities, and feeling less able to resist eating in the face of both emotional and social cues that might promote eating. When these self-report dimensions are integrated with food-related features of the home environment (that is, food distributed more widely in highly visible locations and greater capacity for food storage), the data underscore the relevance of the individual's perception of food and food availability, as well as the individual's capacity for self-regulation of food consumption in an environment where food tends to be more pervasive.

The absence of differences between obese and nonobese groups also may be instructive. There were no obesity group differences in the proportion of individuals who reported engaging in activities while eating meals (for example, watching television, reading, talking), and no differences in physical proximity to the grocery store, regularity of grocery

shopping or total amount of money spent on food. Overall self-reported PA was similar across the two groups, and the mental component of quality of life did not differ. However, obese individuals reported engaging in less ‘very hard’ PA (for example, jogging, swimming, singles tennis, digging) and reported poorer sleep. Owing to increasing data highlighting the importance of sleep in regulating appetite, metabolism and body weight (for review, see Beccutia and Pannaina[30]), the poorer sleep reported among obese individuals may not be surprising, but this relationship would be worthy of further investigation.

There were several limitations of this study. First, the cross-sectional data precludes making causal attributions between study predictors and obesity status. In addition, the statistical approach to building a model predicting obesity status was intended to minimize the influence of Type I error, but owing to the multiple comparisons in the study, risk of Type I error is increased. Because this study was a broad exploration of obesity-related factors in multiple varied domains, statistical correction (for example, Bonferroni correction) is likely to be excessively conservative[31,32] because of the risk of increased Type II error. However, results of the univariate analyses should be interpreted cautiously in light of the multiple comparisons. Also, the sample recruited for the study was mostly white and included a greater proportion of women than men, therefore generalizability of the results to a broader community may be limited. Furthermore, it was not possible to identify foods purchased specifically for study participants in the food receipt data. Although data analyses included statistical control of number of individuals in the participant’s household to address food purchases for others, this approach does not provide precise data regarding food purchasing behavior.

Overall, the sample appeared to be in good health, with similar numbers of chronic conditions and medications in the obese and nonobese groups. However, the higher blood sugar level and lower high-density lipoprotein cholesterol among obese participants may reflect early signs of underlying health conditions commonly associated with obesity. In the final regression analysis, lower weight-related self-esteem, larger amounts of food present in the home and less healthy food consumption were prominent, reflecting the relevance of self-perceptions, food choices and food consumption among obese individuals. The latter findings are consistent with data from Phelan *et al.*[12] evaluating environmental and psychosocial predictors among weight loss maintainers and treatment-seeking obese. However, they found that depressive symptoms did not discriminate between the two groups, and their study did not include a measure of self-esteem or other self-report symptom measure.

This study is the first to examine detailed home environment and food purchasing variables in combination with psychological and social variables to better understand correlates of obesity among adults. Self-esteem has been an important component of weight loss programs among children and adolescents as well as among patients with eating disorders, and prior investigators have suggested the importance of self-esteem for weight loss.[33] These data suggest that self-esteem is associated with obesity status and may be relevant for better understanding obesity in adults, in combination with less healthy food consumption in the home environment and greater availability of food in the home environment. Indeed, the AWL participants in this sample reported significantly lower self-esteem ($F(1,96) = 36.26$, P

< 0.001). Lower self-esteem among obese individuals may result from ineffectual efforts to lose weight but also may reflect a more profound negative self-view, especially in the context of the social environment. Although recent intervention research has documented influences of environmental factors on weight loss success,[12,13] data from this study suggest it may be important in future studies of adult obesity and the environment to include assessment of self-esteem and perhaps other socially influenced indicators of psychological well-being.

ACKNOWLEDGEMENTS

This work was supported by a grant from the Ohio State University Food Innovation Center and by Award Number Grant UL1TR001070 from the National Center for Advancing Translational Sciences, NIH.

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Table 1

Means (s.e.) and proportions for demographic and health variables by obesity group

Variable	*Nonobese (***n** *= 50)*	*Obese (***n** *= 50)*
Age (years)	42.41 (2.16)	45.77 (2.27)
Age of household (years)	34.23 (2.80)	37.32 (3.19)
	range: 7–58	range: 9–74
Education (years)	16.35 (0.36)	16.00 (0.38)
People in home (#)	2.26 (0.16)	2.47 (0.17)
BMI	23.66 (0.57)	36.80 (0.60)***
Fat percent	21.60 (0.51)	39.91 (0.53)***
WHR	0.87 (0.01)	0.94 (0.01)***
Glucose	83.02 (1.83)	89.16 (1.87)*
TC	156.69 (4.61)	158.55 (4.76)
HDL	55.07 (2.14)	46.29 (2.14)**
LDL	79.91 (4.17)	86.18 (3.92)
TRG	109.80 (11.04)	132.06 (10.94)
Medical conditions (#)	2.38 (0.43)	3.39 (0.46)
Medications (#)	2.94 (0.55)	4.18 (0.58)
Annual income		
<$25 000	20%	16%
$25 000-$50 000	12%	31%
$50 000-$75 000	24%	22%
>$75 000	43%	31%
Sex (% female)	50%	72%*
Race (% white)	86%	74%
Marital status (% married)	44%	52%
Attempting weight loss (% yes)	31%	82%***
Smoking (% no)	94%	88%
Alcohol use (% yes)	86%	78%
Shopping (% weekly)	58%	52%

Abbreviations: BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TC, total cholesterol; TRG, triglycerides; WHR, waist–hip ratio.

* Note: $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$;

#, number; least square means controlling for sex.

Table 2

Means (s.e.) for food availability by obesity group

Variable	*Nonobese* n = *50*	*Obese* n = *50*
Food security		
Food insecurity	0.23 (0.20)	1.11 (0.21)***
Groceries and meals		
Store distance (miles)	3.04 (0.43)	3.18 (0.45)
Money spent on groceries (US $)	65.59 (11.48)	95.04 (11.95)
Shopping frequency	1.54 (0.11)	1.57 (0.11)
Restaurant meals	2.06 (0.10)	2.24 (0.10)
Fast food meals	2.08 (0.13)	2.29 (0.13)
Meals at table	1.56 (0.11)	1.80 (0.11)
Single meal prep	1.48 (0.10)	1.51 (0.11)
Receipts		
Grocery costs/week (US $)	310.52 (27.26)	319.76 (28.50)
Restaurant costs/week (US $)	36.06 (6.74)	38.96 (6.93)
Fast food costs/week (US $)	10.61 (3.41)	22.83 (3.56)**
Fast food visits/week	1.22 (0.26)	2.23 (0.27) **
Total food costs (US $)	390.63 (34.40)	428.40 (35.97)
Visibility and storage		
Refrigerators in home (#)	1.08 (0.06)	1.23 (0.06)*
Freezers in home (#)	0.15 (0.07)	0.36 (0.07)*
Visible food locations	3.84 (0.29)	4.20 (0.30)
Highly visible food locations	2.53 (0.18)	3.18 (0.20)**
Cabinet proportion	0.49 (0.02)	0.51 (0.02)
Refrigerator proportion	0.57 (0.02)	0.58 (0.02)
Distance from favorite locations to food (meters)	7.66 (0.37)	8.93 (0.38)*
Perceived distance (meters)	7.65 (0.64)	9.58 (0.67)*
Shelf inventory		
Total food groups	53.58 (2.48)	63.47 (2.61)**
Entrees	3.74 (0.28)	5.49 (0.29)***
Protein	6.56 (0.49)	8.97 (0.51)***
Fruit	8.04 (0.53)	8.06 (0.55)
Vegetables	10.20 (0.64)	11.11 (0.67)
Cereal	2.82 (0.19)	3.22 (0.20)
Dairy	5.70 (0.40)	6.36 (0.42)
Snacks	3.18 (0.24)	4.01 (0.26)*
Sweets	6.34 (0.54)	8.97 (0.57)**
Condiments	3.24 (0.11)	3.62 (0.12)*
Beverages (non-alcoholic)	1.86 (0.15)	2.15 (0.16)

Variable	*Nonobese* n = *50*	*Obese* n = *50*
Alcohol	1.90 (0.16)	1.50 (0.17)

* Note: $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$;

#, number; least square means controlling for sex; Visible food locations = # of places food is visible in the home; Amount of foods visible = # of food types visible in the home; Distance = distance from favorite location to food storage locations; Perceived distance = distance from favorite location to food storage locations.

Table 3

Means (s.e.) for eating activities, food consumption and leisure by obesity group

Variable	*Nonobese (n = 50)*	*Obese (n = 50)*
Food frequency questionnaire		
Calories	2101.04 (133.56)	2245.77 (139.63)
Fat	75.22 (6.23)	82.59 (6.52)
Carbohydrates	259.59 (16.52)	282.99 (17.27)
Alternate Healthy Eating Index		
Total score	47.78 (1.75)	36.42 (1.83)**
Fruit score	3.96 (0.39)	2.76 (0.40)*
Vegetable score	6.06 (0.44)	4.08 (0.46)**
Nuts and soy score	4.91 (0.54)	2.56 (0.57)**
Meat ratio score[a]	6.89 (0.50)	5.64 (0.52)
Cereal fiber score	8.27 (0.31)	6.96 (0.32)**
Trans fat score[b]	8.64 (0.20)	7.45 (0.21)**
Polyunsat:fat score[c]	6.88 (0.32)	5.96 (0.34)*
Alcohol score	2.17 (0.40)	1.02 (0.42)*
Leisure		
# of televisions in home	1.96 (0.21)	2.46 (0.22)
# of items of exercise equipment in home	2.36 (0.30)	2.55 (0.31)
Meals		
Meal duration (mean, s.e.)	21.07 (1.27)	19.83 (1.32)
Meal partners (mean, s.e.)	0.50 (0.08)	0.59 (0.08)
Activities while eating		
Television (% yes)	80%	86%
Computer (% yes)	46%	36%
Talking (% yes)	56%	56%
Reading (% yes)	42%	34%

*Note: $P < 0.05$;

**$P < 0.001$;

#, number; least square means controlling for sex.

[a]Ratio of white meat to red meat.

[b]Trans fat as a percent of total calories.

[c]Ratio of polyunsaturated fat to fat.

Table 4

Means (s.e.) for self-report questionnaires by obesity group

Variable	*Nonobese (n = 50)*	*Obese (n = 50)*
Psychosocial functioning		
HADS (total)	6.98 (0.73)	9.52 (0.77)*
HADS (anxiety)	4.88 (0.50)	5.75 (0.53)
HADS (depression)	2.10 (0.36)	3.77 (0.37)**
ESE (total)	2.61 (0.17)	3.69 (0.18)***
ESE (negative affect)	2.18 (0.19)	3.32 (0.20)***
ESE (socially acceptable situations)	3.23 (0.19)	4.26 (0.20)***
SF36 (mental health)	82.72 (2.24)	74.75 (2.36)**
Social support		
PSSS (total)	5.64 (0.18)	5.53 (0.19)
PSSS (family)	5.73 (0.20)	5.19 (0.21)
PSSS (friends)	5.73 (0.19)	5.59 (0.20)
PSSS (significant other)	5.48 (0.24)	5.82 (0.25)
SF36 (social role functioning)	89.64 (3.17)	79.05 (3.29)*
Quality of life		
SF36 (general health perceptions)	80.27 (3.07)	65.98 (3.27)***
SF36 (physical component score)	53.51 (1.31)	49.67 (1.40)*
SF36 (mental component score)	52.26 (1.52)	48.58 (1.61)
IWQOL (self-esteem)	27.59 (0.81)	20.86 (0.85)***
IWQOL (sexual life)	19.12 (0.50)	16.94 (0.52)***
Sleep (PSQI)	4.54 (0.47)	6.41 (0.49)**
Physical activity (2-week average)		
Total energy expenditure (kcal kg^{-1} per week)	286.18 (5.5)	279.90 (5.79)
Moderate activity (hours/week)	10.29 (1.08)	10.38 (1.13)
Hard activity (hours/week)	2.84 (0.69)	3.34 (0.72)
Very hard activity (hours/week)	2.73 (0.38)	1.28 (0.39)**

Abbreviations: ESE, Eating Self-efficacy Scale; HADS, Hospital Anxiety and Depression Scale; IWQOL, Impact of Weight on Quality of Life Scale; PSSS, Perceived Social Support Scale; PSQI, Pittsburgh Sleep Quality Index; Physical activity, 7-Day Physical Activity Recall; SF-36, Medical Outcomes Survey, Short Form-36.

* Note: $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$;

least square means controlling for sex.

Table 5

Logistic regression for final model

Variable	*B*	*s.e.*	*Odds ratio*	*Wald Statistic*	*95% CI for odds ratio*
ESE (total)	0.42	0.28	1.53	2.25	0.88 — 2.66
IWQOL (self-esteem)	− 0.55	0.21	0.58	6.53*	0.38 — 0.88
SF-36 (social functioning)	0.01	0.02	1.01	0.61	0.98 — 1.05
Sleep (PSQI)	0.04	0.11	1.04	0.15	0.85 — 1.28
Very hard PA	− 0.07	0.11	0.93	0.43	0.74 — 1.16
Food security	0.46	0.31	1.58	2.14	0.86 — 2.94
Shelf inventory (total)	0.03	0.02	1.04	4.40*	1.00 — 1.07
AHEI (total)	− 0.06	0.03	0.94	3.90*	0.89 — 1.00
Sex	− 0.48	0.64	0.62	0.56	0.18 — 2.17

Abbreviations: AHEI, Alternate Healthy Eating Index; CI, confidence interval; ESE, Eating Self-Efficacy Scale; IWQOL, Impact of Weight on Quality of Life; PA, physical activity measured with 7-Day Physical Activity Recall; PSQI, Pittsburgh Sleep Quality Index; SF-36, Medical Outcomes Short Form-36.

* Note: $P < 0.05$;

Model $\chi^2(9) = 57.37$, $P < 0.0001$; Hosmer-Lemeshow test: $\chi^2(8) = 17.69$, $P = 0.02$.