Published in final edited form as:
Ann Behav Med. 2011 October ; 42(2): 210–220. doi:10.1007/s12160-011-9286-9.

Obesogenic Family Types Identified through Latent Profile Analysis

Brian C. Martinson, Ph.D.,
HealthPartners Research Foundation, Mail Stop: 21111R, P.O. Box 1524, 55440-1524, Minneapolis, MN, USA

Gabriela VazquezBenitez, Ph.D.,
HealthPartners Research Foundation, Mail Stop: 21111R, P.O. Box 1524, 55440-1524, Minneapolis, MN, USA

Carrie D. Patnode, Ph.D.,
Kaiser Permanente Center for Health Research, Portland, OR, USA

Mary O. Hearst, MPH., Ph.D.,
Division of Epidemiology and Community Health, University of Minnesota, Minneapolis, MN, USA

Nancy E. Sherwood, Ph.D.,
HealthPartners Research Foundation, Mail Stop: 21111R, P.O. Box 1524, 55440-1524, Minneapolis, MN, USA

Division of Epidemiology and Community Health, University of Minnesota, Minneapolis, MN, USA

Emily D. Parker, Ph.D.,
HealthPartners Research Foundation, Mail Stop: 21111R, P.O. Box 1524, 55440-1524, Minneapolis, MN, USA

John Sirard, PhD,
Curry School of Education, University of Virginia, Charlottesville, VA, USA

Keryn E. Pasch, MPH., Ph.D., and
Department of Kinesiology and Health Education, University of Texas at Austin, Austin, TX, USA

Leslie Lytle, Ph.D.
Division of Epidemiology and Community Health, University of Minnesota, Minneapolis, MN, USA

Brian C. Martinson: Brian.C.Martinson@HealthPartners.Com

Abstract

Background—Obesity may cluster in families due to shared physical and social environments.

Purpose—This study aims to identify family typologies of obesity risk based on family environments.

Methods—Using 2007–2008 data from 706 parent/youth dyads in Minnesota, we applied latent profile analysis and general linear models to evaluate associations between family typologies and body mass index (BMI) of youth and parents.

Correspondence to: Brian C. Martinson, Brian.C.Martinson@HealthPartners.Com.

Conflicts of Interest There are no actual or potential conflicts of interest for any of the co-authors of this manuscript.

Results—Three typologies described most families with 18.8% "Unenriched/Obesogenic," 16.9% "Risky Consumer," and 64.3% "Healthy Consumer/Salutogenic." After adjustment for demographic and socioeconomic factors, parent BMI and youth BMI *Z*-scores were higher in unenriched/obesogenic families (BMI difference=2.7, $p<0.01$ and BMI Z-score difference=0.51, $p<0.01$, respectively) relative to the healthy consumer/salutogenic typology. In contrast, parent BMI and youth BMI Z-scores were similar in the risky consumer families relative to those in healthy consumer/salutogenic type.

Conclusions—We can identify family types differing in obesity risks with implications for public health interventions.

Keywords

Latent profile analysis; Family types; Youth; Obesogenic environment

Introduction

Overweight and obesity remain major public health concerns in children and adults despite recent evidence of stabilizing prevalence [1–5]. The National Survey of Children's Health documented a 10% increase in the prevalence of obesity among children and adolescents ages 10–17 between 2003 and 2007 [6]. Moreover, this prevalence increased by 23–33% for children in low-education, low-income, and higher-unemployment households. Similar socioeconomic disparities in childhood overweight and obesity have recently been documented in the UK [7].

Concern regarding the prevalence of youth overweight and obesity over the past several decades [2, 3, 8] has stimulated much research into its causes. A diverse range of risk factors likely contribute to its etiology [9–12]. Suspected contributing factors range from genetic and biological to behavioral, familial, environmental (home, school, and neighborhood environments), cultural, demographic, and socioeconomic [13–15]. Increasingly, socioecological approaches to understanding adolescent overweight and obesity have drawn attention to the inter-relatedness of many of these factors [16–18]. These developments have led researchers to employ a variety of pattern analytic methods to examine the joint, overlapping, and reinforcing effects of various putative risk factors [19– 22]. A brief review of findings from four such studies illuminates how such methods can inform research on the etiology of childhood obesity and documents the need for the further examination of family characteristics in this paper.

Using data from the National Survey of Children's Health, two studies have used moderator analysis [22] and classification and regression tree (CART) analyses [19] to identify groups of adolescents with homogenous sociodemographic factors and potentially modifiable risk and protective factors for overweight. Both studies identified poverty as a significant factor, with the CART analysis further illuminating numerous pathways of determinants of overweight which varied by gender, race/ethnicity, and income. A third study using data from the National Longitudinal Study of Adolescent Health employed cluster analysis to identify groups of adolescents with homogeneous weight-related behaviors [21]. Seven behavior pattern clusters were identified for males and six for females. Although few of the clusters predicted obesity for males, among females, behavior pattern clusters which included high participation in school clubs and sports were less likely to be obese. However, here too, the associations appear to be at least partially driven by family socioeconomic status, as adolescents in the school clubs and sports cluster were also more likely to be white and to have parents with higher education and income than those in other clusters. Lastly, latent class analysis has recently been used in a large regional study of adolescents to identify homogeneous subgroups with differing risks of overweight or obesity, based on parenting styles and practices in their families [20]. This study identified four unique parenting "types." Although significant associations were found between these parenting types and adolescent body mass index (BMI), the associations differed between sons and daughters and the mothers' and fathers' parenting styles and practices.

Largely unexplored are the shared physical and social environment of the household/family, how members spend their time and, importantly, overall patterns of consumption. This is particularly relevant because the behaviors of other household members and the material conditions of the home itself may affect both youth and parent weight. In addition, our ability to target public health messages that resonate with different types of families depends on an understanding of family type beyond demographic or structural differences. Two recent studies using data from the National Longitudinal Study of Adolescent Health have documented that, beyond the expected genetic contribution to youth weight, the family and home environment contribute substantially as well [13, 14].

In this paper, we address this gap by employing latent profile analysis (LPA) to examine the social and physical environments of families and households to identify family typologies that may be particularly prone to or protective against obesity. We propose that families can be usefully grouped into a finite number of relatively homogeneous "clusters" along a latent dimension of "obesogeneity" on the basis of parent responses to questions about the social and physical environment in the home. We define family or household obesogeneity as the extent to which the characteristics of the home environment and the behavioral patterns of the adults in the family tend to promote unhealthy weight gain among its members.

Our work is informed by a conceptual model based on a socioecological approach to examining the etiology of childhood obesity, including aspects of the home environment that may influence the risk of childhood obesity. This model identifies youth weight as the outcome of interest, with the most proximally related behaviors being eating, activity, and sedentary behaviors. Three contextual areas believed to affect these behaviors included intrapersonal factors of both youth and adults (e.g., beliefs, attitudes, preferences about food, and activity options); the social environment (e.g., peer and family influence through normative expectations, modeling of behaviors, and reinforcements) and the physical environment (e.g., availability and accessibility of healthful options in the home, school, and neighborhood). While the contextual, behavioral, and health outcomes (weight) may interact in myriad ways, the model simplifies the relationships by conceiving of behaviors as the factors being most proximal to the weight outcomes while the physical and social environments may exert more distal influence. Our LPA models focus on aspects of the family/household that would be expected to influence the weight status of household members—specifically, the behaviors related to energy balance, the physical environment of the household, and affective or intrapersonal elements of the social environment, specifically parenting style and parental depressive symptoms. We specifically excluded variables representing socioeconomic status for the construction of the obesogenic typologies, choosing instead to examine how the family types may differ by socioeconomic status. To the extent that LPA allows us to define family types differing in their obesity risk based on behavioral patterns and home environment and moving beyond risk attributable to socioeconomic status, it may provide important insight into how to more effectively tailor public health messages about providing a healthful home environment.

Methods

Study Design and Participants

The sample is from the Identifying Determinants of Eating and Activity (IDEA) study (NIH U54 CA116849) and the Etiology of Childhood Obesity (ECHO) study (NIH R01 HL085978); both studies are etiologic, longitudinal studies examining factors that may be related to unhealthy weight gain in youth [16]. Identical measurement protocols allowed us to combine these two samples, increasing our potential power for understanding relationships. For the IDEA study, 349 youth ages 10–16 and one significant adult in their life (usually a parent) were recruited from within a seven-county metropolitan area from Minneapolis and St. Paul, MN, USA in 2006–2007. Youth were invited to participate regardless of weight status and were recruited from: (1) an existing cohort of youth participating in the Minnesota Adolescent Community Cohort Tobacco Study [23], (2) a Minnesota Department of Motor Vehicle list restricted to the seven-county metro area, and (3) a convenience sample drawn from local communities.

For the ECHO study, 374 youth and a parent were recruited from the membership of HealthPartners health plan within the seven-county metropolitan area of Minneapolis, St. Paul, MN, USA between June 2007 and March 2008. We used a recruitment procedure that targeted a range of overweight and healthy weight youth and parents and that oversampled minorities. To be eligible, youth were required to be current Health-Partners members, in grades 6 through 11 in the fall of 2007, residing in one of the randomly selected middle or high school districts included in the sample, and have a parent willing to participate and be willing to allow their names and contact information to be sent from HealthPartners to the study team at University of Minnesota for further eligibility screening, consent, and measurement.

In both the IDEA and ECHO studies, youth were excluded if they or their families expected to move from the area in the next 3 years, if they had a medical condition that affected their growth, were non-English speaking or otherwise had difficulty comprehending English, or had any other physical or emotional condition that would affect their diet/activity levels or make it difficult to complete measurements. The human subjects committees at the University of Minnesota and Ohio State University approved the study. The IDEA and ECHO studies collected the same measures on all participants. Appending the data from the studies provided a larger, more diverse sample.

Measures

Variables—On the basis of the conceptual model guiding the research [16], we chose variables related to the family social and physical environments of eating and activity and included depression to represent intra-individual factors. These variables represent risk factors for unhealthy eating, activity, or weight. For this research, we used data on the home environment and social and behavioral data from the participating adults. While behavioral data were also available from the youth, we reasoned that parental decisions frequently impact the entire family and their behaviors provide important role modeling likely to impact the behaviors of the youth in the home. In addition, the number of variables that can be used in LPA is limited.

Variables Representing the Social Environment

All social environment variables came from a self-administered parent survey completed at a clinic visit at the University of Minnesota’s Epidemiology Clinical Research Center.

Positive Family Meal Patterns—The Positive Family Meal Patterns is a summative score composed of 11 items related to family mealtimes, such as, "Did all, or most, of your family living in your home eat dinner together?", "Was milk served at dinner in your home?", and "I allow my child to watch TV during a family meal." Each item was dichotomized to reflect positive vs. less-positive eating practices. For example, the question "Did all, or most, of your family living in your home eat dinner together?" had five response categories: "never", "1 or 2 times", "3 or 4 times", "5 or 6 times," and "7 times" per week. Parents who reported eating evening meals together at least five times a week were coded as "1" to indicate a positive eating practice. Never serving soft drinks and serving fruit, vegetables, and milk "almost every day" were considered positive. Not allowing TV or phone calls during dinner and not eating in the car were also positive. Positive Family Meal Patterns scores ranged from 0 to 11. Construct validity for the score has been demonstrated with more positive meal patterns being inversely related to body mass index of both adults and youth in a family. Analyses included the Positive Family Meal Patterns as a continuous variable.

Family Rules—The family rules scale (range 4–16) was composed of four items, including "We have family rules about what/when children eat", "We have family rules about time spent on TV/video games", "When I was a child, my parents enforced rules about what/when I ate", and "When I was a child, my parents enforced rules about TV watching." Four response options ranged from "strongly disagree" to "strongly agree." Cronbach's alpha was 0.66. Family rules related to diet and activities have been correlated with BMI among youth and adolescents [24].

Authoritative Parenting Style—An authoritative parenting style (range 6–24) was determined on the basis of six items developed by Jackson et al. [25] including "I give reasons for the rules I make", and "I praise my child for doing a good job on things." Response categories ranged from "1" (strongly disagree) to "4" (strongly agree); thus, higher scores indicate a higher level of authoritative parenting. Cronbach's alpha was 0.79. Parenting style has been correlated with a variety of risk and protective factors in youth [26–28].

Parent TV/DVD Watching—Parents were asked how many hours they spend watching TV and DVDs on a typical weekday and weekend. Response categories were "none," "<half-hour," "0.5–2 h," "2.5–4 h," "4.5–6 h," and "6+ hours." We constructed a weighted score of responses according to day of the week (range 1–6). A dose-response relationship has been found between time watching TV and weight status in children [29] and adults [30].

Parent Fast Food Purchases—Parents were asked how many times they bought food at a fast food restaurant. Responses were "never or rarely," "1 time per month," "2 or 3 times per month," "1 or 2 times per week," "3 or 4 times per week," "5 or 6 times per week," "1 time per day," "2 times per day," and "3 or more times per day", resulting in a scale ranging from 1 to 9. Higher energy density, poorer nutrient quality, and larger portions associated with foods consumed away from home have been implicated in overweight and obesity [31].

Variables Representing the Physical Environment

Parents were given the Physical Activity and Media Inventory and the Home Food Inventory at the clinic visit and asked to complete it at home and return within 2 weeks in a self-addressed, postage-paid envelope.

Home Physical Activity and Media Equipment—The Physical Activity and Media Inventory is a self-report inventory of physical activity and screen media equipment in the home that documents access and availability of equipment (range 0–18.3) [32]. Developmental testing of the Physical Activity and Media Inventory showed strong test–retest reliability for physical activity equipment (inter-class correlation [ICC]=0.76–0.99) and screen media equipment (ICC=0.72–0.96); criterion validity assessment showed moderate to strong correlations (physical activity, 0.67–0.98; media, 0.79–0.96) [32].

Density of physical activity equipment (e.g., bicycles and soccer equipment) was calculated by summing the number of items and dividing by the number of rooms. Media density was similarly calculated, summing the number of screen media items (e.g., television sets, video game consoles) and dividing by the number of locations (range 0–3.9).

Home Fruit and Vegetable Variety and Obesogenic Food Availability—The Home Food Inventory is a self-report inventory of different types of food in the home [33]. Criterion validity tests using Cohen's kappa ranged from 0.61 to 0.83; correlations between staff and participant ranged from 0.71 to 0.91, depending on category [33].

Parents recorded the presence of fruits and vegetables by indicating a "yes" or "no" for each of 26 listed fruits and 20 vegetables. A summed score was created by adding the number of fruits and vegetables the parent recorded (range 4–40). An obesogenic score was created as an indicator of the overall healthfulness, or obesogenicity, of the food environment. The obesogenic score was derived by summing across these food groups: regular-fat dairy products, frozen and prepared desserts, savory snacks, added fats, sugar-sweetened beverages, processed meat, high-fat microwavable foods, candy, and unhealthy foods in the kitchen (range 4–60) [33]. We hypothesize that a greater variety of fruits and vegetables and lesser variety of obesogenic foods are negatively related to BMI.

Variable Representing Intra-individual Factors

Depression—Depression was measured using the Kandel and Davies depression scale (range 6–30) [34], which includes six items asking perceptions about things like, "Feeling too tired to do things" and "Feeling nervous or tense," with responses of "not at all," "somewhat," and "very much." Cronbach's alpha was 0.79. Depressive symptoms are associated with a higher risk of adults and youth being overweight or obese [35].

Demographic and Socioeconomic Data on the Family

Sociodemographic data came from parent and student surveys. Adolescent characteristics included gender, grade in school (sixth to eighth grade, ninth grade or higher), race (non-white, white), and whether they lived with both parents or just one. Variables tapping socioeconomic status were obtained from the parent survey and included whether the parent was college educated and if their youth qualified for free or reduced-price school lunch [36].

Obesity

BMI—Trained staff measured the height of youth and parents with a Shorr height board (Irwin Shorr, Olney, MD, USA) and weight and BMI using a bioelectrical impedance device (TBF-300A Body Composition Analyzer, Tanita, Arlington Heights, IL, USA). BMI was calculated as weight (kg)/ height (m^2). For adolescents, BMI percentiles and Z-scores were derived from Centers for Disease Control and Prevention Growth Charts [37].

Analysis

Appending the data files, data management, and analyses were conducted using v.9.1 of the SAS System for Windows (SAS Institute, Inc., Cary, NC, USA) and MPLUS v.6.1 [38]. We excluded *n*= 19 subjects with missing values in any of the 10 variables used in the LPA. In addition, because variables measuring TV/DVD watching, fast food purchases, and density of media and physical activity equipment were positively skewed, they were log transformed. For the LPA, input variable Z-scores were used. LPA is a pattern analytic statistical technique appropriate for identifying such a set of mutually exclusive groupings of observations, in our case the "observations" being parent/youth dyads representing family/ household units. LPA accepts as input measures that are nominal, ordinal, or continuous indicators [39]. We estimated a series of latent profile models, ranging from one to four groups. Model fit was evaluated using both the Lo–Mendell–Rubin (LMR) Likelihood Ratio test (LRT) and the size-adjusted Bayesian information criterion (BIC) [40]. In addition, we considered the conceptual interpretation of the resultant profiles in determining the best model. Variables were treated as conditionally independent. Subjects were assigned to profiles with the highest member probability, which ranged from 0.79 to 0.90 across the three groups. Probabilities closer to one for a single class and closer to zero for the remaining classes suggest good group assignment and distinct classes.

To describe each profile, we compared family environment and behavior variables across profile groups. Chi-square tests were run to examine sociodemographic differences between profiles (e.g., adolescent gender, race, and family structure). Lastly, we estimated multivariable general linear regression models using adolescents' BMI Z-scores and parents' BMIs as dependent variables. We present the multivariable results as mean BMI Z-scores and parents' BMI separately by category of the family profile variable with three levels of adjustment: no model adjustment, adjusted by demographic and family structure variables, and with further adjustment for two socioeconomic proxy variables. We evaluated correlations between our covariates using the kappa statistic to determine whether multi-collinearity was present which might reduce the precision of the regression estimates. Associations ranged from kappa of 0.04–0.24, and with the exception of the association between parental education and free or reduced price lunch were less than 0.20.

Results

Sample Characteristics

In Table 1, we present basic demographic characteristics of the IDEA and ECHO samples, both separately and combined. ECHO student participants were younger, had higher prevalence of overweight or obesity, were less likely to have a white parent, less likely to have both parents present, and more likely to be eligible to receive free or reduced price lunch.

Latent Profile Analysis Results

Based on the Vuong–Lo–Mendell–Rubin likelihood ratio test and BIC values, and an inspection of the parameter estimates from two-, three- and four-class models, we determined that the three-profile model provided the best fit (LMR LRT for two versus three classes 142.5, $p<0.01$, and BIC=19226 for three classes versus BIC=19191 for four classes). The classes identified in the three profile model were distinguishable.

In Table 2, we present the means and standard deviations of the family environment and parental behavior variables used in the LPA, displaying values for the total sample, and separately by the three profiles identified in the LPA. In Fig. 1, we present the input variable Z-scores for the three profiles. A group we refer to as "healthy consumer/ salutogenic" families represented 64% of the sample and evinced above average levels of characteristics such as positive family eating practices and family rules, combined with low levels of TV/DVD watching, parental fast food purchases, and home media equipment. They appeared to have resources and use them in ways that support healthy weight of the youth and adults.

A second group we will call "unenriched/obesogenic," which represented 18.8% of the sample, were characterized by less enriched material environments and homes that appeared less socially supportive and structured. Families in this profile are the least likely to display positive family meal practices and had parents who reported the highest levels of depressive symptoms and reported fewer family rules around meal time. Parents in this group also reported the most screen time, the lowest density of physical activity equipment and the lowest variety of foods in the house whether fruits and vegetables or more obesogenic offerings.

A third class we call "risky consumer," represented 16.9% of the sample, and was characterized by parents reporting the highest levels of fast food consumption, the greatest density of both physical activity and media equipment in the home, the most variety of fruits and vegetables in the home but also the largest availability of obesogenic foods in the home. This profile also evinces low levels of positive family meal practices, higher levels of depressive symptoms in the parents, fewer family rules, less authoritative parenting styles, and more parental screen time as compared to the healthy consumer/salutogenic family profile. Table 3 shows the breakdown of demographic and socioeconomic variables among the three profiles. Significant differences were found by profiles for all variables considered except youth gender and grade. White, college educated parents and families with both mother and father present were over-represented in the healthy consumer/salutogenic group and under-represented in the unenriched/obesogenic group. The unenriched/obe-sogenic group had the most families qualifying for free or reduced lunch at schools. The risky consumer group looked generally more like the overall sample average. No statistically significant differences were observed in the distribution of the family profile measure between the IDEA and ECHO study samples.

Association of Obesogenic/Salutogenic Groups with Obesity

In Table 4, we present adolescent BMI-Z scores (top half of the table) and parent BMI (bottom half of the table), separately by family type classification, and with increasing levels of multivariable adjustment. Model 1 includes just the observed means for the three family types, using the healthy consumer/salutogenic type as the reference typology. Model 2 adds adjustment for demographic characteristics and model 3 adds adjustment for socioeconomic variables.

Family type was associated with youth BMI Z-score, $p < 0.01$ (type III test). Youth in the unenriched/obesogenic group had BMI Z-scores 0.65 ($p<0.01$) above the healthy consumer/salutogenic group. This difference was attenuated after adjusting for demographic and socioeconomic variables, but a significant mean difference 0.51 ($p<0.01$) remained. Youth living in risky consumer families had initially higher BMI Z-scores relative to those in the healthy consumer/salutogenic profile, mean difference 0.26 ($p= 0.01$), but after covariate adjustment, the attenuated association was no longer significant, mean difference 0.18 ($p=0.09$).

Parents in the unenriched/obesogenic group had higher BMI than those in the healthy consumer/salutogenic group, mean difference 4.0 kg/m^2 ($p<0.01$). After adjustment for demographic and socioeconomic variables, this difference was attenuated but remained significant, 2.7 kg/m^2 ($p< 0.01$). Finally, parents in the risky consumer group had initially higher BMI than parents in the healthy consumer/ salutogenic families, 1.9 kg/m^2 ($p<0.01$)

but this association was attenuated and became statistically non-significant after multivariable adjustment 0.8 kg/m^2 (p=0.18).

Discussion

The family typologies identified in our study are strongly correlated with multiple measures of demographic and socioeconomic factors, suggesting that the physical and social environments of homes reflect families' socioeconomic status. For both youth and parents, being in a family identified as unenriched/obesogenic type as compared to the healthy consumer/salutogenic type is a significant predictor of higher BMI Z-scores and BMI, respectively, even after controlling for demographic and socioeconomic factors. In contrast, for both youth and parents, living in a risky consumer-type family was not a significant predictor of their respective BMI Z-scores or BMI after such adjustment.

This is largely consistent with the three previously mentioned studies using pattern analytic techniques with large national datasets [19, 21, 22] all of which found that socioeconomic-related measures were keys to defining salient population subgroups with respect to risk for obesity in youth. However, our typologies appear to explain additional variation in both youth and adult weight status, as indicated by the significant associations of the unenriched/obesogenic profile with higher youth BMI Z-score and higher adult BMI, even after adjusting for demographic and socioeconomic measures. While the social and physical environments of these families appear to contribute additional risk of obesity, the fact that our typologies also differ notably by their sociodemographic characteristics suggests an inter-relatedness. We speculate that these intra-household patterns may reflect these families' embodiment of, or their "embeddedness" in, the social structure [41, 42]. The differences across these subgroups suggest that quite divergent public health responses may be needed to foster healthy weight status among their members.

In the case of families in the healthy consumer/ salutogenic profile, this clearly advantaged group appears to both have adequate resources, and to be using them to provide largely health-promoting home and family environments. These families are the most likely to have adequate financial resources and to report supportive family social practices. Families in this group appear to need little from public health practitioners. At the other end of the spectrum are families in the unenriched/obesogenic profile. These families are significantly more likely to be economically disadvantaged; with lower rates of college education, the highest rates of free and reduced-price lunch, the lowest likelihood of having two parents at home and the highest representation of minorities. These families also appear to offer less socially supportive and healthful environments. This combination of lower socioeconomic status, representing structural disadvantage, paired with less healthful home environments is associated with a higher likelihood of unhealthy weight status for both adolescents and adults.

Education only-based public health interventions may offer this group little help for improving their home environments. Parents in these families might benefit from clear public health messages about concrete factors such as the importance of positive family meal practices, setting rules about meal times, and reducing television viewing and purchasing fast food. However, we need to recognize that the social environment is difficult to change with their limited resources. More comprehensive structural and systemic changes may need to be considered, including interventions to change more than just their choices.

In contrast, families in the risky consumer profile do not appear to be resource poor, although they are the least likely to have a college-educated parent, and 16% of them have youth qualifying for free or reduced-price lunch. How these families use their resources is somewhat mixed, and on the whole, the family environment in this profile would, on its face, seem likely to confer substantial risk for obesity. Compared with the other groups, families in the risky consumer profile are more likely to have a high media-density home, obesogenic foods in the house, and parents who report high levels of screen time and fast-food purchases. In many ways, these families fit the profile of quintessential working-class middle America; targeted by advertising, with consumption patterns that appear to reflect the influences of such campaigns. This is also the group at which public health messaging frequently appears to be targeted.

It is therefore remarkable that after adjusting for demographic and socioeconomic measures, the BMI Z-scores for youth and BMI for parents in this group are not significantly different from those in the healthy consumer/ salutogenic profile. Potentially protective factors in the physical environment of these families include relatively high density of physical activity equipment and high variety of fruits and vegetables, both of which may mitigate the putative impact of the less favorable factors of low Positive Family Meal Patterns index, relative lack of family rules, high variety of obesogenic foods, high media density, screen time, and fast food purchases. Demographically, these families are also more likely to have two parents present, and the youth are more likely to be white, relative to the unenriched/obesogenic group. We can only speculate about other potentially protective factors not taken into account in our analyses, but based on other recent studies, candidates here include the possibility that these families live in less-stressful or less-deprived neighborhoods [43– 45], or that are more conducive to physical activity [46, 47], relative to the unenriched/ obesogenic group. The relatively more enriched environment of these families may also buffer against the putative effects of family- or individual-level stressors on their risks of obesity [48–50]. So, as with the unenriched/obesogenic group, we must ask what traditional public health messaging has to offer these families in terms of protection against youth and parent overweight. Such efforts might include strategies aimed at helping these families resist or overcome aggressive consumer marketing campaigns. Yet, based on the suggestive evidence here, any impact of such efforts would likely have to operate through factors other than the family/ household environment measures we have examined.

Previous research has focused on demographic and socioeconomic factors to characterize families and their obesity risk [6, 7, 19, 21, 22]. Our LPA clearly identifies three types of families that differ significantly on measures that have often been used to distinguish socioeconomic status; abundant evidence suggests that obesity risk varies by socioeconomic status. However, our analysis takes this approach a step farther by grouping families based on other intra-household factors, specifically elements of the family social environment, the availability of healthy and less healthy food and activity options in the home, and parental depressive symptoms, representing intra-individual factors. Our data suggest that there are important connections between structural factors (e.g., socioeconomic status) and intra-household behavior patterns as elements of family life related to obesity risk in both youth and adults.

We can only speculate as to the underlying factors that cause these families to express different levels of obesity risk, such as marketing, cultural expectations, or some other social influence. Commercial influences and advertisements may systematically sell obesogenic products to specific populations or market segments. For example, perhaps our healthy consumer/salutogenic group is targeted to purchase more healthy foods and more equipment to foster physical activity, while our risky consumer group is targeted to purchase more obesogenic foods and watch more TV.

While we believe our findings offer important lessons, we also acknowledge that some caveats apply. Limitations include the relatively homogeneous sample and the fact that the

IDEA and ECHO studies were conducted in only one Midwest metropolitan area. The analytic sample is predominantly white and of higher socioeconomic background, which may limit the ability to generalize our findings beyond this sample. Our reliance on responses from only one parent to characterize the household may also be a limitation. To the extent that two parents in a household have discordant responses to the measures used in our LPA, their family may have been classified differently if responses from both parents had been available. In addition, LPA is an exploratory, not confirmatory, method and, as such, does not yield definitive population subgroups. As prior pattern analytic studies demonstrate, the groupings resulting from such analyses are also strongly determined by which potential risk factors are included for analysis. One of the limitations of LPA is that the number of indicator variables that can be assessed is limited. We chose our indicator variables on the basis of the conceptual model underpinning this research. Yet future research may use the same analytic technique and examine other variables such as weight status of friends, social cohesion, the neighborhood environment, or a wider range of attitudinal variables to further tease out family typologies related to obesity risk. There are also limitations to the use of the “analyze-classify-analyze” strategy we have employed [51]. Specifically, the probabilistic nature of latent profile group assignment is not explicitly taken into account in the modeling, which means that our profile classifications should be taken as suggestive as opposed to definitive. A limitation of the Positive Family Meal Patterns index is that for eight of the 11 component questions, responses about the frequency of given behaviors are dichotomized such that families reporting a frequency above a “cut point” receive a “point” for that positive behavior while families reporting any frequency below that cut point do not. This may result in some misclassification of families such that the Positive Family Meal Patterns index may underestimate the existence of some positive family meal practices. Finally, our analyses are also cross-sectional, precluding examination of the temporal ordering of associations.

The strengths of this study should also be noted. First, the novel designs of the IDEA and ECHO studies in collecting data on individual characteristics, family norms and practices, and the home environment from both parents and adolescents was an ideal scenario in which to explore the consumption behaviors and other family patterns in households. The identification of distinct family types provided interesting data that suggest the need for different public health intervention strategies for different family types.

Acknowledgments

For study support, the authors would like to thank Transdisciplinary Research in Energetics and Cancer (TREC) Initiative (grant #1U54CA116849-01) and the National Heart, Lung and Blood Institute (grant #R01HL085978).

References

1. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. JAMA. 2010 Jan 20; 303(3):242–249. [PubMed: 20071470]
2. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of Overweight and obesity in the United States, 1999–2004. JAMA. 2006 April 5; 295(13):1549–1555. 2006. [PubMed: 16595758]
3. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. JAMA. 2002; 288(14):1728–1732. [PubMed: 12365956]
4. Institute of Medicine and Committee on Prevention of Obesity in Children and Youth. Preventing childhood obesity: Health in the balance. Washington, D.C.: The National Academies Press; 2005.
5. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. JAMA. 2010; 303(3):235–241. [PubMed: 20071471]

6. Singh GK, Siahpush M, Kogan MD. Rising social inequalities in US childhood obesity, 2003–2007. Ann Epidemiol. 2010 Jan; 20(1):40–52. [PubMed: 20006275]
7. Stamatakis E, Wardle J, Cole TJ. Childhood obesity and overweight prevalence trends in England: Evidence for growing socioeconomic disparities. Int J Obes (Lond). 2010 Jan; 34(1):41–47. [PubMed: 19884892]
8. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. JAMA. 2004; 291(23):2847–2850. [PubMed: 15199035]
9. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. Nutr Rev. 2008 Mar; 66(3):123–140. [PubMed: 18289177]
10. Procter KL. The aetiology of childhood obesity: A review. Nutr Res Rev. 2007 Jun; 20(1):29–45. [PubMed: 19079859]
11. van der Horst K, Oenema A, Ferreira I, et al. A systematic review of environmental correlates of obesity-related dietary behaviors in youth. Health Educ Res. 2007 Apr; 22(2):203–226. [PubMed: 16861362]
12. Birch LL, Davison KK. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. Pediatr Clin North Am. 2001 Aug; 48(4):893–907. [PubMed: 11494642]
13. Martin MA. The intergenerational correlation in weight: How genetic resemblance reveals the social role of families. AJS. 2008; (114 Suppl):S67–S105. [PubMed: 19569401]
14. Nelson MC, Gordon-Larsen P, North KE, Adair LS. Body mass index gain, fast food, and physical activity: Effects of shared environments over time. Obesity (Silver Spring). 2006 Apr; 14(4):701–709. [PubMed: 16741273]
15. Dietz WH, Gortmaker SL. Preventing obesity in children and adolescents. Annu Rev Public Health. 2001; 22(1):337–353. [PubMed: 11274525]
16. Lytle LA. Examining the etiology of childhood obesity: The IDEA study. Am J Community Psychol. 2009; 44(3–4):338–349. [PubMed: 19838791]
17. O'Brien M, Nader PR, Houts RM, et al. The ecology of childhood overweight: A 12-year longitudinal analysis. Int J Obes (Lond). 2007 Sep; 31(9):1469–1478. [PubMed: 17406272]
18. Egger G, Swinburn B. An "ecological" approach to the obesity pandemic. BMJ. 1997 August 23; 315(7106):477–480. 1997. [PubMed: 9284671]
19. BeLue R, Francis LA, Rollins B, Colaco B. One size does not fit all: Identifying risk profiles for overweight in adolescent population subsets. J Adolesc Health. 2009 Nov; 45(5):517–524. [PubMed: 19837359]
20. Berge JM, Wall M, Bauer KW, Neumark-Sztainer D. Parenting characteristics in the home environment and adolescent overweight: A latent class analysis. Obesity (Silver Spring). 2010; 18(4):818–825. [PubMed: 19816417]
21. Boone-Heinonen J, Gordon-Larsen P, Adair LS. Obesogenic clusters: Multidimensional adolescent obesity-related behaviors in the U.S. Ann Behav Med. 2008 Dec; 36(3):217–230. [PubMed: 19067096]
22. Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: Analyzing independent and joint associations. Ann Epidemiol. 2008 Sep; 18(9):682–695. [PubMed: 18794009]
23. Widome R, Forster JL, Hannan PJ, et al. Longitudinal patterns of youth access to cigarettes and smoking progression: Minnesota Adolescent Community Cohort (MACC) study (2000–2003). Prev Med. 2007 December; 45(6):442–446. [PubMed: 17719080]
24. Lytle LA, Hearst MO, Fulkerson JA, Murray DM, Martinson BC, Klein E, et al. Examining the relationships between family meal practices, family stressors, and the weight of youth in the family. Ann Behav Med. 2011; 41(3):353–362. [PubMed: 21136225]
25. Jackson CN, Henriksen L, Foshee VA. The Authoritative Parenting Index: predicting health risk behaviors among children and adolescents. Health Educ Behav. 1998; 63(5):218–223.
26. Berge JM. A review of familial correlates of child and adolescent obesity: What has the 21st century taught us so far? Int J Adolesc Med Hlth. 2009 Oct-Dec; 21(4):457–483.

27. van der Horst K, Kremers S, Ferreira I, Singh A, Oenema A, Brug J. Perceived parenting style and practices and the consumption of sugar-sweetened beverages by adolescents. Health Education Research. 2007 Apr; 22(2):295–304. [PubMed: 16908496]

28. Davison KK, Cutting TM, Birch LL. Parents' activity-related parenting practices predict girls' physical activity. Med Sci Sports Exerc. 2003 Sep; 35(9):1589–1595. [PubMed: 12972881]

29. Crespo CJ, Smit E, Troiano RP, Bartlett SJ, Macera CA, Andersen RE. Television watching, energy intake, and obesity in US children: Results from the third National Health and Nutrition Examination Survey, 1988–1994. Arch Pediatr Adolesc Med. 2001 Mar; 155(3):360–365. [PubMed: 11231802]

30. Healy GN, Dunstan DW, Salmon J, Shaw JE, Zimmet PZ, Owen N. Television time and continuous metabolic risk in physically active adults. Med Sci Sports Exerc. 2008 Apr; 40(4):639–645. [PubMed: 18317383]

31. Bowman SA, Vinyard BT. Fast food consumption of US adults: Impact on energy and nutrient intakes and overweight status. J Am Coll Nutr. 2004 Apr; 23(2):163–168. [PubMed: 15047683]

32. Sirard JR, Nelson MC, Pereira MA, Lytle LA. Validity and reliability of a home environment inventory for physical activity and media equipment. Int J Behav Nutr Phys Act. 2008; 5:24. [PubMed: 18445280]

33. Fulkerson JA, Nelson MC, Lytle LA, Moe S, Heitzler C, Pasch KE. The validation of a home food inventory. Int J Behav Nutr Phys Act. 2008; 5:55. [PubMed: 18983668]

34. Kandel D, Davies M. Epidemiology of depressive mood in adolescents: An empirical study. Arch Gen Psychiatry. 1982 October; 39(10):1205–1212. [PubMed: 7125850]

35. Herva A, Laitinen J, Miettunen J, et al. Obesity and depression: Results from the longitudinal Northern Finland 1966 Birth Cohort Study. Int J Obes. 2005; 30(3):520–527.

36. US Department of Agriculture, Service FaN. [Accessed September 8, 2009] School meals: Income eligibility guidelines. 2009. http://www.fns.usda.gov/cnd/Governance/notices/iegs/IEGs.htm

37. National Center for Health Statistics. CDC growth charts: United States. 2000

38. Muthén, BO.; Muthén, L. Mplus user's guide. 5th ed.. Los Angeles, CA: Author; 2007.

39. Bartholomew, DJ.; Knott, M. Latent variable models and factor analysis. 2nd edition. London: Arnold; 1999.

40. Raftery AE. Bayesian model selection in social research. Sociological Methodology. 1995; 25:111–163.

41. McMichael AJ. Prisoners of the proximate: Loosening the constraints on epidemiology in an age of change. Am J Epidemiol. 1999 May 15; 149(10):887–897. 1999. [PubMed: 10342797]

42. Krieger N. Proximal, distal, and the politics of causation: What's level got to do with it? Am J Public Health. 2008 Feb; 98(2):221–230. [PubMed: 18172144]

43. Stafford M, Brunner EJ, Head J, Ross NA. Deprivation and the development of obesity a multilevel, longitudinal study in England. Am J Prev Med. 2010 Aug; 39(2):130–139. [PubMed: 20621260]

44. Greves Grow HM, Cook AJ, Arterburn DE, Saelens BE, Drewnowski A, Lozano P. Child obesity associated with social disadvantage of children's neighborhoods. Soc Sci & Med. 2010; 71(3): 584–591. [PubMed: 20541306]

45. Singh GK, Kogan MD, van Dyck PC. A multilevel analysis of state and regional disparities in childhood and adolescent obesity in the United States. J Community Health. 2008; 33(2):90–102. [PubMed: 18049885]

46. Adams MA, Sallis JF, Kerr J, Conway TL, Saelens BE, Frank LD, et al. Neighborhood environment profiles related to physical activity and weight status: A latent profile analysis. Prev Med. 2011; 52(5):326–331. [PubMed: 21382400]

47. Norman GJ, Adams MA, Kerr J, Ryan S, Frank LD, Roesch SC. A latent profile analysis of neighborhood recreation environments in relation to adolescent physical activity, sedentary time, and obesity. J Public Health Manag Pract. 2010; 16(5):411–419. [PubMed: 20689390]

48. Wardle J, Chida Y, Gibson EL, Whitaker KL, Steptoe A. Stress and adiposity: A meta-analysis of longitudinal studies. Obesity. 2010; 19(4):771–778. [PubMed: 20948519]

49. Mattei J, Demissie S, Falcon LM, Ordovas JM, Tucker K. Allostatic load is associated with chronic conditions in the Boston Puerto Rican Health Study. Soc Sci & Med. 2010; 70(12):1988–1996. [PubMed: 20381934]
50. Lohman BJ, Stewart S, Gundersen C, Garasky S, Eisenmann JC. Adolescent overweight and obesity: Links to food insecurity and individual, maternal, and family stressors. J Adolesc Health. 2009; 45(3):230–237. [PubMed: 19699418]
51. Lanza, ST.; Flaherty, B.; Collins, LM. Latent class and latent transition analysis. In: Schinka, J.; Velicer, W., editors. Research Methods in Psychology. Vol. Vol 2. Hoboken, NJ: John Wiley & Sons, Inc.; 2003. p. 663-685.

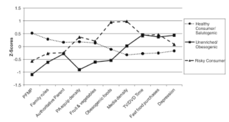

Fig. 1.
Z-scores of latent profile analysis input variables

Table 1

Sample demographic description—IDEA and ECHO subsamples and combined sample

	IDEA	**ECHO**	**Total**
	***N*=332**	***N*=374**	***N*=706**
Parent mean age±SD	47.6±5.1	44.9±6.4	46.2±61
Youth mean age±SD	16.4±1.7	14.0±1.7	15.1±6
Youth mean BMI Z-score±SD	0.3±0.9	0.5±1.1	0.4±1
Parent mean BMI±SD	26.7±5.4	28.0±6.6	27.3±6.1
Parent male gender, *N* (%)	82 (24.7%)	64 (17.1%)	146 (20.7%)
Parent white race, *N* (%)	328 (98.8%)	324 (86.6%)	652 (92.4%)
Qualified for free/reduced price lunch, *N* (%)	23 (6.9%)	59 (15.8%)	82 (11.6%)
Youth male gender, *N* (%)	161 (48.5%)	182 (48.7%)	343 (48.6%)
Youth grade 5–8, *N* (%)	57 (17.2%)	231 (61.8%)	288 (40.8%)
Both parents present, *N* (%)	264 (79.8%)	266 (71.1%)	530 (75%)
Parent overweight or obese, *N* (%)	185 (55.7%)	218 (58.3%)	403 (57.1%)
Youth overweight or obese, *N* (%)	64 (19.3%)	116 (31.0%)	180 (25.5%)

IDEA International Day for Evaluation of Abdominal obesity, *ECHO* Employment Change and Health Outcomes

Table 2

Latent profile analysis input variables according to latent profile groups, mean±SD

	Healthy Consumer/salutogenic *N*=442 (64.3%)	Unenriched/obesogenic *N*=129 (18.8%)	Risky consumer *N*=116 (16.9%)	Total *N*=687
Positive family meal practices	7.3±1.5	3.5±1.7	4.7±1.8	6.2±2.3
Family rules	10.9±1.9	8.9±1.9	9.6±1.7	10.3±2.0
Authoritative parenting style	20.8±2.1	19.9±2.2	19.8±2.1	20.5±2.2
Home PA equipment density	5.2±2.4	2.6±1.6	6.1±3.3	4.9±2.7
Home fruit and vegetable variety	21.9±5.9	16.8±.9	22.5±5.7	21.0±6.2
Home obesogenic food availability	30.6±7.4	26.2±7.8	41.3±36.6	31.6±8.7
Home media equipment density	0.7±0.3	0.8±0.3	1.1±0.4	0.8±0.4
Parent TV/DVD watching	2.2±0.5	2.8±0.9	2.7±0.7	2.4±0.7
Parent fast food consumption	3.0±1.2	3.9±1.5	4.0±1.1	3.3± 1.3
Parent depressive symptoms	14.9±3.7	17.7±4.5	16.0±4.5	15.6±4.1

TV television, *DVD* digital video disk, *PA* physical activity

Table 3

Demographic and socioeconomic characteristics by latent profile groups, *n*=687 (*n*, percentage of sample)

Variable	Healthy consumer/salutogenic	Unenriched/obesogenic	Risky consumer	*p* Value
Youth gender, male	223 (50.5%)	53 (41%)	57 (49.1%)	0.17
Youth grade, 5–8th grade	191 (43.2%)	43 (33.3%)	41 (35.3%)	0.07
Youth race, white	405 (91.6%)	80 (62.0%)	99 (85.3%)	<0.01
Both mother and father present	376 (85.3%)	61 (47.3%)	84 (72.4%)	<0.01
Qualified for free/reduced-price lunch	26 (5.9%)	32 (24.8%)	19 (16.4%)	<0.01
Parent education, ≥college degree	386 (87.3%)	74 (57.8%)	62 (53.5%)	<0.01
Mean youth age±SD	15.3±1.9	15.5±2.0	15.0±2.1	0.02
Mean parent age±SD	45.9±6	44.9±6.9	46.7±5.5	<0.01
IDEA	219 (49.6%)	54 (41.9%)	55 (47.4%)	0.31
ECHO	223 (54.4%)	75 (58.1%)	61 (52.6%)	

Table 4

Youth BMI Z-score and parent BMI according to adjustment level, mean (95%CI), and mean differences; *n*=685

	Healthy consumer/salutogenic	Unenriched/obesogenic	Risky consumer	*p* Value[a]
Youth				
Model 1				
Mean values (95%CI), Mean differences	0.24 (0.14–0.33) Reference	0.88 (0.71–1.05) 0.65, *p*<0.01	0.49 (0.31–0.68) 0.26, *p*=0.01	<0.01
Model 2				
Mean values (95%CI) Mean differences	0.26 (0.17–0.36) Reference	0.80 (0.61–0.98) 0.54, *p*<0.01	0.49 (0.32–0.67) 0.23, *p*=0.03	<0.01
Model 3				
Mean values (95%CI) Mean differences	0.28 (0.18–0.37) Reference	0.78 (0.60–0.97) 0.51, *p*<.01	0.46 (0.27–0.64) 0.18, *p*=0.09	<0.01
Parent				
Model 1				
Mean values (95%CI) Mean differences	26.2 (25.7–26.8) Reference	30.2 (29.2–31.2) 4.0, *p*<0.01	28.2 (27.1–29.2) 1.9, *p*<0.01	<0.01
Model 2				
Mean values (95%CI), Mean differences	26.4 (25.9–27.0) Reference	29.7 (28.6–30.7) 3.2, *p*<0.01	28.0 (27.0–29.1) 1.6, *p*=0.01	<0.01
Model 3				
Mean values (95%CI) Mean differences	26.6 (26.1–27.2) Reference	29.4 (28.3–30.4) 2.7, *p*<0.01	27.5 (26.4–28.6) 0.8, *p*=0.18	<0.01

Model 1 observed means; *Model 2* adjusted by gender, grade level, race, both parents present; *Model 3* model 2+ free/reduced price lunch and parent education

[a] *p* Value for overall difference, type 3 test