Published in final edited form as:
J Adolesc Health. 2013 August ; 53(2): 280–286. doi:10.1016/j.jadohealth.2013.03.007.

Patterns of Physical Activity, Sedentary Behavior and Diet in US Adolescents

Ronald J. Iannotti, PhD and **Jing Wang, PhD**
Prevention Research Branch, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development

Lack of physical activity (PA), excess sedentary behavior, and unhealthful diets contribute to adolescent obesity and early development of cardiovascular risk factors.[1–3] In addition, each of these behaviors has other health consequences. Child and adolescent physical activity has been related to adiposity, elements of Metabolic Syndrome, physical, mental and social health, and academic and cognitive performance.[1,2,4–6] Adolescent screen -based sedentary behavior (SB), particularly television viewing (TV), has been related to subsequent adiposity, risk for cardiovascular disease, metabolic syndrome, health complaints, physical aggression, and tobacco and alcohol use, and negatively related to quality of life, psychological well-being, and quality of family relationships.[1,5–9] A diet high in energy dense foods such as sugar -sweetened beverages, sweets, chips, and French fries has been positively associated with adiposity, waist circumference, total cholesterol, low density lipoproteins, diastolic blood pressure, and plasma triglycerides and glucose and negatively related to psychological functioning, while diets high in fiber from consumption of fruits and vegetables have been negatively related to adiposity and indicators of the Metabolic Syndrome.[10,11]

Pediatric recommendations for reducing the risk of cardiovascular disease suggest that the optimum approach is a combination of increased PA, reduced SB, and improved diet quality.[1] Establishment of healthful patterns during childhood and adolescence is important because physical activity and dietary habits track during adolescence and from adolescence to adulthood.[4]

Although adolescent PA, SB, and diet may not be strongly related to each other, there is evidence that these behaviors are interrelated within individuals;[9] that is, that there might be a limited number of individual patterns of adolescent PA, SB, and diet. In small regional samples, obesogenic behavior patterns combining PA, SB, diet, and weight consciousness have been identified in fourth-grade children[12] and combining PA and SB in adolescents.[13,14] However, to our knowledge, no studies have examined obesogenic behavior patterns in a nationally representative sample of US adolescents or examined how these patterns relate to physical and psychological health. Identifying these patterns could

Corresponding Author: Ronald J. Iannotti, PhD, Prevention Research Branch, Eunice Kennedy Shriver National Institute of Child, Health and Human Development, 6100 Executive Blvd., 7B05, Bethesda, MD 20892-7510, Tel: 301-435-6951, Fax: 301-402-2084, iannottr@mail.nih.gov.

Conflict of Interest: None

Contributor's Statement: RJI contributed to the study conception and design, acquisition of data, interpretation of data, and drafting the article for important content. JW contributed to the paper conception, analysis and interpretation of the data, and drafting the article for important content. Both authors approve the version submitted for publication.

foster understanding of their development and maintenance, their broader health consequences, and potential avenues for intervention. The purpose of this study was to identify patterns in adolescents' obesogenic behaviors, demographic differences across these patterns, and the relationship of these patterns to indicators of physical and psychological health.

Methods

Sample and Procedure

A nationally representative sample of US students in grades 6 to 10 was recruited from 230 schools in 39 states with census regions and grades as strata and classrooms as the primary sampling units. African-American and Hispanic students were oversampled to obtain better estimates for those groups. Participants completed the 2005/2006 Health Behavior in School-aged Children (HBSC)[15] survey anonymously with a response rate of 87%. Youth assent and, depending on requirements of participating school districts, active or passive parental consent were obtained. The study protocol was reviewed and approved by the Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development.

Measures

Socio-demographic variables—Socio-demographic variables included gender, age, race/ethnicity (Caucasian, African-American, Hispanic, and others) and family affluence. Family socioeconomic status was estimated with the Family Affluence Scale (FAS): the adolescent having his/her own bedroom, frequency of family traveling vacations, and number of family computers and motor vehicles.[16] The FAS produced a continuous scale from 0 to 9.

Physical activity (PA)—A definition of physical activity was provided, "any activity that usually increases your heart rate and makes you get out of breath some of the time," and examples of activities preceded the question "How often over the past 7 days have you been physically active for a total of at least 60 minutes per day". The measure has reasonable validity (r = .37 with 5-day accelerometer data) and reasonable accuracy for classifying adolescents meeting recommendations for 60 min/day of PA for at least 5 days/week (sensitivity = 83%).[17,18] PA was dichotomized: < 5 days/week; and ≥ 5 days/week, the threshold for decreasing odds of obesity in adolescents.[19]

Screen-based Sedentary Behaviors (SB)—Students were asked how many hours a day, in their free time, they usually: 1) watched television (including videos and DVDs); 2) played games on a computer or games console (Playstation, Xbox, GameCube, etc); and 3) used a computer for chatting on-line, internet, emailing, homework, etc. Separate questions were asked for weekday and weekend. Response categories ranged from "*none at all*" to "*about 7 or more hours a day*". These HBSC items have acceptable test-retest reliability (*ICC*s ranging from .76 to .81) and validity (rs ranging from .36 to .54).[20] For each SB, a weighted average of weekdays and weekend days was dichotomized: > 2hr/day; and ≤ 2 hr/day, consistent with the recommendations of the American Academy of Pediatrics.[21]

Dietary intake—As part of a validated brief food frequency questionnaire,[22] participants indicated how many times a week they usually ate fruits, vegetables, sweets (chocolates and candy), sweetened soft drinks, chips, and French fries. The response options were "never," "less than once a week," "once a week," "2 to 4 days a week," "5 to 6 days a week," "once a day, every day" and "every day, more than once." For each food category, a dichotomous variable was created: ≥ 1/day; and < 1/day.

Weight status—Adolescents reported their heights and weights. Using body mass index percentiles derived from the gender- and age-specific growth charts of the Centers for Disease Control and Prevention,[23] a four-category weight status variable was created: underweight or at risk for underweight (≤ 15th percentile); normal weight (16th to 84th percentile); overweight or at risk for obesity (85th to 94th percentile); and obese (≥ 95th percentile).

Weight loss behavior—Adolescents were asked whether they were currently on a diet or doing something else to lose weight. Four categories of weight loss behavior were generated from the four choices: “no, my weight is fine;” “no, but I should lose some weight;” “no, because I need to put on weight;” and, “yes.”

Body dissatisfaction—Five items from the body image subscale of the Body Investment Scale[24] (“I am frustrated with my physical appearance,” “I am satisfied with my appearance ,”“I hate my body,” “I feel comfortable with my body” and “I feel anger toward my body”) assessed body dissatisfaction on a 5-point scale (“strongly agree” to “do not agree at all”). A higher mean score across items indicated greater body dissatisfaction.

Physical Symptoms—Adolescents indicated how often in the last 6 months they experienced: (1) headache; (2) stomach-ache; (3) backache; and (4) feeling dizzy. Responses were coded from one to five: “*rarely or never,*” “*about every month,*” “*more than once a week,*” “*about every week*” and “*about every day*”(Cronbach’s *alpha* = .70). A higher mean score indicated more physical symptoms.[25]

Depression—Participants indicated how often in the past 30 days they: (1) were very sad; (2) were grouchy or irritable, or in a bad mood; (3) felt hopeless about the future; (4) felt like not eating or eating more than usual; (5) slept a lot more or a lot less than usual; and (6) had difficulty concentrating on their school work.[26] Responses were coded one to five: “*never,*” “*seldom,*”“ *sometimes,*” “*often*” and “ *always*” (Cronbach’s *alpha* =.80). A higher mean score indicated greater depressive tendencies.

Life satisfaction—A ladder with rungs numbered vertically zero to ten was pictured and participants asked to choose a number with the top “10” for the best possible life and the bottom “0” for the worse possible life.[27]

Overall health—A single item measured overall health, with response options coded from one to four: “*poor,*” “*fair,*” “*good,*” and “*excellent.*”[28]

Data Analysis

Latent Class Analysis (LCA) identifies latent classes based on individuals’ patterns of responses to multiple categorical variables. The primary advantage of LCA over cluster analysis is that LCA is a model-based method and as such should generalize to other independent populations, thus making evaluation of classes in a cross-sectional sample appropriate and in a nationally representative sample even more robust.[29] Our application of LCA identifies the probability of individuals within a class reporting each health behavior, the prevalence of each pattern of health behaviors within a nationally representative sample, the characteristics that differentiate members across classes, and the health indicators associated with these patterns.

A series of LCA models were evaluated using Mplus version 5.1[30] with stratification, cluster and sampling weights to accommodate the complex sampling structure of the US

HBSC data. To choose the optimal number of classes that best fit the data, LCA models with increasing numbers of classes were evaluated.

Model selection was based on conceptual implications, model parsimony and fit statistics, including loglikelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size adjusted Bayesian information criterion (ABIC), and average latent class probabilities for most likely membership (ACPs). In the current study, latent classes were defined by probabilities that individuals in each class met criteria for physical activity, television viewing, computer use, video gaming, and consumption of fruit, vegetables, sweets, sweetened soft drinks, chips and fries. After the optimal number of classes was selected, demographic differences across latent classes were examined by adding gender, grade, race/ethnicity, and FAS as covariates. Finally, the extracted latent classes were compared on physical and psychological variables, e.g., weight status, weight loss behavior, body dissatisfaction and depressive symptoms. Obesogenic behaviors and their correlates frequently differ by gender; therefore, analyses were also conducted separately by gender.

Results

Sample Characteristic

Among the 9,227 adolescents who completed the survey, 21 were excluded due to missing information on all PA, SB, and diet items, resulting in an analytic sample of 9,206 (mean age: 13.9 years), 48.4% males, 48.9% Caucasian Americans, 17.9% African-Americans, and 19.1% Hispanic Americans. Most (65.5%) children were in the normal weight classification with the balance being overweight (17.1%), obese (13.6%), or underweight (3.7%).

Descriptive Statistics: Prevalence Rates

Descriptive statistics for PA, SB and diet are reported in Table 1. Majorities of participants reported ≥ 5 days/week of PA but also > 2 hrs/day of TV. Boys reported significantly more PA, more video games, and less computer use than girls. Girls reported higher daily intake of sweets, but were less likely to consume sweetened drinks.

Latent Classes

The model fit statistics for 1- to 5-class LCA models are provided in Table 2. Results showed that the loglikelihood values, as well as three information criteria indices (AIC, BIC and ABIC), decreased substantially for models with 1 to 3 classes and moderately for additional classes. The ACP, an indicator of the degree to which classes could be reliably distinguished from one another, was high for models with 2, 3, and 4 classes (>.80).[31] With further consideration of conceptual implications and model parsimony, the 3-class model was selected as the best model and used in subsequent analyses for the full sample and for each gender.

The three latent classes for the full sample are presented in Figure 1. The patterns in item probabilities of each PA, SB and diet item were quite similar for models of each gender (not shown).

The first latent class represents approximately a fourth of respondents with a *Healthful* pattern relative to the other two classes. Class 1 had the highest proportion of members meeting the criterion for PA (63.9%), lowest proportions reporting > 2hr/day of TV (37.7%), video games (12.0%), or computer use (18.2%), the highest proportions consuming at least one serving of fruits (83.0%) or vegetables (79.3%) per day, and among the lowest proportions indicating intake of energy dense foods including sweets (22.0%), sweetened soft drinks (10.7%), chips (8.5%), and fries (2.8%).

Approximately one fourth of the participants were in Class 2, which was labeled *Unhealthful*. Across the three classes, these adolescents had the highest percentage exceeding 2hr/day TV (74.5%), video games (36.4%) and computer use (32.3%), and the highest proportions with daily intake of sweets (73.3%), sweetened soft drinks (77.8%), chips (80.9%), and fries (44.4%). However, relative to the other two classes, members of Class 2 had a moderate probability of meeting the criterion for PA (50.1%) or consuming fruits (45.5%) or vegetables (35.5%) daily.

Typical adolescents (47.2%) were in Class 3 and had a pattern of the lowest percentage meeting the criteria for PA (45.6%) or consuming fruits (10.1%) or vegetables (9.4%) and infrequently consumed sweets (16.3%), sweetened soft drinks (24.5%), chips (7.5%), or fries (2.7%). Members of this class were moderate relative to the other two classes with respect to TV (53.5%), video games (18.2%), and computer use (23.3%).

Socio-demographic differences in latent class membership were examined with *Class 1: Healthful* as the reference group (see Table 3). Due to missing information on socio-demographic variables, 223 (2.4%) subjects were excluded from this analysis. Compared to the *Healthful* pattern group, adolescents in the *Unhealthful* group were less likely to be Caucasian and more likely to have lower FAS scores. Adolescents in the *Typical* group were comparatively more likely to be males, older, and either African-American or Hispanic, and to have lower FAS scores. The socio-demographic differences were consistent across genders, with the exception of no significant racial/ethnic difference between the *Typical* and *Healthful* groups in the model with males only.

Comparing Classes on Health Indicators

Compared to the other two latent classes, adolescents demonstrating the *Healthful* pattern reported that they had fewer symptoms of depression, better life satisfaction, and better overall health (Table 4). Compared to other girls, girls in this class were more likely to be normal weight and less likely to be obese; they were less likely to indicate they should gain weight. However, boys in this class were more likely than other boys to indicate they were trying to lose weight.

Compared to the other two classes, adolescents in the *Unhealthful* class were less likely to indicate they were currently trying to lose weight, with girls in this class more likely than other girls to report they were not trying to lose weight because they thought they needed to gain weight and boys more likely to indicating their weight was fine. Adolescents in this class also reported more frequent physical and depressive symptoms.

The *Typical* group reported the highest levels of body dissatisfaction, with *Typical* girls less likely to indicate their weight was fine and boys more likely than other boys to report that they should lose weight but were not currently trying. However, compared to the *Unhealthful* class, *Typical* adolescents were less likely to be underweight or report symptoms of depression.

Discussion

To our knowledge, this is the first application of latent class analysis to identify patterns in obesogenic behaviors in a nationally representative sample of US adolescents. The unique combination of obesogenic behaviors in each class has clear implications for cardiovascular health, each class is related to other indicators of physical and mental health, and each class suggests different approaches for public health efforts. This is a national sample and at a public health level, differences of 1.7% to 4.6% in prevalence of overweight/obesity across classes are quite significant.

Class 1: *Healthful* identified a pattern in approximately one fourth of the students who were more likely than the other classes to meet recommendations for PA and SB, had the highest frequencies of fruit and vegetables consumption, and low levels of consumption of sweets, sweetened drinks, chips, and fries. In both girls and boys, the *Healthful* pattern was reflected in other measures of health such as higher life satisfaction, lower depression, and higher overall health status. These findings are consistent with other studies showing a positive association of higher levels of PA, lower levels of SB, and a healthful diet with positive physical and psychological indicators.[4–12,32] Even though most of these adolescents met recommendations for daily PA, they did not meet nutritional guidelines with respect to fruit, vegetables and energy-dense foods.[3,19,21] One focus of future research could be to identify the social and environmental conditions that promote development and maintenance of this pattern. Interventions with this group should particularly promote improvements in diet and preventing the usual decline in PA during adolescence.

Adolescents in Class 2, the *Unhealthful* group, had essentially the opposite pattern of obesogenic behaviors as the *Healthful* group, with low PA, high SB, low fruit and vegetable intake and the highest intake of sweets, sweetened drinks, chips and fries. It is possible that some *Unhealthful* youth have adopted this pattern because they are actively trying to gain weight. If this is the case, this is not a healthful approach to gaining weight: consuming unhealthful quantities of energy dense foods, while not taking advantages of the health benefits associated with a more active lifestyle.[2–6,19,32] Future studies of this group could determine the causal direction of the links between this pattern of obesogenic behaviors and potentially maladaptive associations with symptoms of depression and somatic problems, and potential determinants of these relations. One potential hypothesis is that the high rate of physical symptoms contributes to a pattern of high sedentary behavior and symptoms of depression and low life satisfaction and perceived health. However, high rates of adolescent sedentary behaviors have been associated with a similar pattern of physical and psychological health.[5,6,8] Interventions at the school and clinic level could focus on decreasing the proportion of free time spent in sedentary activities and incorporating more moderate intensity physical activity into their lifestyle, including active transport to school. If weight gain is one of the motivations for some in this class, school and practice-based interventions might focus on the effect of physical activity on increased lean muscle mass and the disadvantages of energy dense foods for health in general.[3,9–11,32]

Class 3 represents the largest group of US adolescents, provides evidence that the dominant lifestyle varies from recommendations regarding PA, SB and diet, and is associated with poorer physical and mental health. The pattern of weight status, weight loss behavior, and body dissatisfaction suggests that the *Typical* group may be older adolescents who are overweight/obese, dissatisfied with their body, and trying to lose weight by focusing exclusively on reducing dietary intake. That this is the most prevalent group and has the highest prevalence of overweight/obesity is a concern. Identification of successful interventions with this group might be a priority because of the public health implications. If these adolescents are motivated by a desire to manage their weight, they might benefit from interventions that focus on the weight-related benefits of daily physical activity and a diet with proportionately more fruits and vegetables. They might need to learn the dual role of caloric intake and physical activity in weight management.[2–4,8–11]

Health disparities were evident across the three latent classes and the potential contribution of obesogenic environments should not be ignored. Adolescents with lower family affluence and minority adolescents were more likely to exhibit less healthful patterns of diet and physical activity. Potential socio-environmental contributors to these differences include neighborhood differences in access to recreational facilities and produce markets,[33,34] school differences in food services and policies supporting physical activity,[35] and family

differences in availability of healthful versus unhealthful foods and support for physical activity.[36,37]

It is difficult to compare these results to other studies using cluster analysis or LCA because of differences in the health behaviors included in analyses and the age of the samples.[13,14,38] In addition, the current study included a nationally representative sample of US students and therefore the classes should be more robust across samples and time compared to local samples. However, the classes identified in this national sample of adolescents are similar to three of the five classes identified by Huh et al.[12] in a regional sample of younger children: high PA and healthy diet; high SB and high fat/sugar diet but not overweight conscious; dieting without exercise but overweight conscious. Further work is necessary to confirm that these patterns are stable over time in US adolescents, that correlates of these patterns are consistent in other cultures, and whether membership in these classes predict subsequent health outcomes.

Because these data are cross-sectional, they cannot tell us about the development and determinants of these patterns. However, research identifying the age of onset of these patterns could facilitate early intervention. And if the relation of obesogenic behaviors with psychological health is causal, educating adolescents about these links might motivate development of healthier patterns. Further study of the characteristics of adolescents exhibiting each pattern, for example, the motivations for adolescents exhibiting each of these patterns and the potential influence of parents and peers on these patterns, could be informative. LCA suggests that individual patterns of health behaviors exist even though the behaviors may not be correlated. Thus, interventions might target determinants of these patterns even though the determinants of individual behaviors within a pattern might be unrelated.

The primary limitation of this study is the cross-sectional design which prohibits inference about causal relations between the obesogenic behaviors and physical and psychological correlates. Another limitation is the reliance on self-report for height and weight; however, studies have shown good correlations between self-reported and measured body mass index making it suitable for examining associations in population studies.[39,40] Strengths of the study also need to be considered including the application of LCA to a nationally representative sample of 6th- through 10th-grade US adolescents and the inclusion of multiple obesogenic behaviors in identifying the latent classes.

Conclusions

Three latent classes were identified in a nationally representative sample, with approximately three out of every four adolescents reporting two unhealthful dietary and activity patterns. One class had the optimum combination of these behaviors and good indicators of mental health. Two classes, both with poorer mental health, varied greatly in consumption of snacks but had lower rates of PA, SB and consumption of fruits and vegetables. The different patterns in these classes suggest that relative rates of PA, SB, and consumption of fruit and vegetables may drive differences in weight status and mental health more than consumption of energy dense snacks and drinks. These findings also suggest that interventions may need to be tailored to different audiences or require different social marketing strategies, combined with formative and efficacy research.

Acknowledgments

This research was supported in part by the intramural research program of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (Contract N01-HD-5-3401) and by the Maternal and Child Health Bureau of the Health Resources and Services Administration with the first author (Ronald J. Iannotti) as

principal investigator. This work was previously reported at the International Society for Behavioral Nutrition and Physical Activity.

References

1. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report. Pediatrics. 2011; 128:S1–S44. [PubMed: 21807703]
2. Strong WB, Malina RM, Bumke CJ, et al. Evidence based physical activity for school-age children. J Pediatr. 2005; 146:732–737. [PubMed: 15973308]
3. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2010. 7. Washington, DC: U.S. Government Printing Office; Dec. 2010
4. Hallal PC, Victora CG, Azevedo RM, Wells JCK. Adolescent physical activity and health. A systematic review. Sports Med. 2006; 36:1019–1030. [PubMed: 17123326]
5. Iannotti RJ, Janssen I, Haug E, et al. Interrelationships of adolescent physical activity, sedentary behaviour, and positive and negative social and psychological health. Int J Public Health. 2009; 54:S191–S198.
6. Iannotti RJ, Kogan MD, Janssen I, Boyce WF. Patterns of Adolescent Physical Activity, Screen-Based Media Use and Positive and Negative Health Indicators in the U.S. and Canada. J Adolesc Health. 2009; 44:493–499. [PubMed: 19380098]
7. DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. Obesity Reviews. 2007; 8:69–81. [PubMed: 17212797]
8. Ussher MH, Owen CG, Cook DG, Whincup PH. The relationship between physical activity, sedentary behaviour and psychological wellbeing among adolescents. Soc Psychiatry Psychiatr Epidemiol. 2007; 42:851–856. [PubMed: 17639309]
9. Utter J, Neumark-Sztainer D, Jeffery R, Story M. Couch potatoes or French fries: Are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? Journal of the American Dietetic Association. 2003; 103:1298–1305. [PubMed: 14520247]
10. Carlson JJ, Eisenmann JC, Norman GJ, Ortiz KA, Young PC. Dietary fiber and nutrient density are inversely associated with the metabolic syndrome in US adolescents. J Am Diet Assoc. 2011; 111:1688–1695. [PubMed: 22027051]
11. Deshmukh-Taskar PR, O'Neil CE, Nicklas NA, Yang SJ, Liu Y, Gustat J, Berenson GS. Dietary patterns associated with metabolic syndrome SES and lifestyle factors in young adults - the Bogalusa Heart Study. Public Health Nutrition. 2009; 12(12):2493–2503. [PubMed: 19744354]
12. Huh J, Riggs NR, Spruijt-Metz D, et al. Identifying patterns of eating and physical activity in children: a latent class analysis of obesity risk. Obesity. 2011; 19:652–658. [PubMed: 20930718]
13. Hair EC, Park MJ, Ling TJ, Moore KA. Risk behaviors in late adolescence: co-occurrence, predictors, and consequences. J Adolesc Health. 2009; 45:253–261. [PubMed: 19699421]
14. Liu J, Kim J, Colabianchi N, Ortaglia A, Pate RR. Co-varying patterns of physical activity and sedentary behaviors and their long-term maintenance among adolescents. J Phys Activ Health. 2010; 7:465–474.
15. Roberts C, Freeman J, Samdal O, et al. The Health Behaviour in School-aged Children (HBSC) study: methodological developments and current tensions. Int J Public Health. 2009; 54 (Suppl 2):S140–150.
16. Currie, C.; Nic Gabhainn, S.; Godeau, E., et al. Inequalities in Young People's Health: HBSC International Report from the 2005/2006 Survey. Copenhagen: WHO Regional Office for Europe; 2008.
17. Prochaska JJ, Sallis JF, Long B. A PA screening measure for use with adolescents in primary care. Arch Pediatr Adolesc Med. 2001; 155(5):554–549. [PubMed: 11343497]
18. Rangul V, Holmen TL, Kurtze N, Cuypers K, Midthjell K. Reliability and validity of two frequently used self-administered PA questionnaires in adolescents. BMC Med Res Methodol. 2008; 8:47. [PubMed: 18627632]

19. Menschik D, Ahmed S, Alexander MH, Blum RW. Adolescent physical activities as predictors of young adult weight. Arch Pediatr Adolesc Med. 2008; 162:29–33. [PubMed: 18180409]
20. Vereecken CA, Todd J, Roberts C, Mulvihill C, Mae L. Television viewing behaviour and associations with food habits in different countries. Public Health Nutr. 2006; 9:244–250. [PubMed: 16571179]
21. American Academy of Pediatrics. Children, adolescents and television. Pediatrics. 2001; 107:423–426. [PubMed: 11158483]
22. Vereecken CA, Maes L. A Belgian study on the reliability and relative validity of the Health Behaviour in School-Aged Children food-frequency questionnaire. Public Health Nutr. 2003; 6(6): 581–8. [PubMed: 14690039]
23. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC Growth Charts for the United States: methods and development. Vital Health Stat. 2002; 11(246)
24. Orbach I, Mikulincer M. The body investment scale: construction and validation of a body experience scale. Psychol Assess. 1998; 10(4):415–425.
25. Haugland S, Wold B, Stevenson J, Aaroe LE, Woynarowska B. Subjective health complaints in adolescence – a cross-national comparison of prevalence and dimensionality. Eur J Public Health. 2001; 11:4–10. [PubMed: 11276570]
26. Dahlberg, LL.; Toal, SB.; Swahn, MH.; Behrens, CB. Measuring violence-related attitudes, behaviors, and influences among youths: a compendium of assessment tools. Atlanta, GA: The National Center for Injury Prevention and Control; 2005.
27. Cantril, H. The pattern of human concern. New Brunswick, NJ: Rutgers University Press; 1965.
28. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. J Health Soc Behav. 1997; 38:21–37. [PubMed: 9097506]
29. Magidson J, Vermunt JK. Latent class models for clustering: a comparison with K-means. Canadian Journal of Marketing Research. 2002; 20(1):36–43.
30. Muthén, LK.; Muthén, BO. Mplus User's Guide. 6. Los Angeles: CA: Muthén & Muthén; 1998–2010.
31. Whitesell NR, Beals J, Mitchell CM, Novins DK, Spicer P, Manson SM, et al. Latent class analysis of substance use: Comparison of two American Indian reservation populations and a national sample. Journal of Studies on Alcohol. 2006; 67(1):32–43. [PubMed: 16536127]
32. Pronk HP, Anderson LH, Crain AL, Martinson BC, O'Conner PJ, Sherwood NE, et al. Meeting recommendations for multiple healthy lifestyle factors. Am J Prev Med. 2004; 27(2S):25–33. [PubMed: 15275671]
33. Boone-Heinonen J, Evenson KR, Song Y, Gordon-Larsen P. Built and socioeconomic environments: patterning and associations with physical activity in U.S. adolescents. Int J Behav Nutr Phys Activ. 2010; 7:45.
34. Ho S-Y, Wong BY-M, Lo W-S, Mak K-K, Thomas GN, Lam T-H. Neighbourhood food environment and dietary intakes in adolescents: sex and perceived family affluence as moderators. Int J Pediatr Obes. 2010; 5:420–427. [PubMed: 20078377]
35. Edmundson E, Parcel GS, Feldman HA, Elder J, Perry DL, Johnson CC, et al. The effects of the child and adolescent trial for cardiovascular health upon psychosocial determinants of diet and physical activity behavior. Prev Med. 1996; 25:442–453. [PubMed: 8812822]
36. Carver A, Timperio A, Hesketh K, Crawford D. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? Soc Sci Med. 2010; 70:1799–1805. [PubMed: 20347200]
37. Patrick H, Nicklas TA. A review of family and social determinants of children's eating patterns and diet quality. J Am Coll Nutr. 2005; 24:83–92. [PubMed: 15798074]
38. Patnode CD, Lytle LA, Erickson DJ, Sirard JR, Barr-Anderson DJ, Story M. Physical activity and sedentary activity patterns among children and adolescents: a latent class analysis approach. Journal of Physical Activity and Health. 2011; 8:457–467. [PubMed: 21597117]
39. Goodman E, Hinden BR, Khandelwal S. Accuracy of teen and parental reports of obesity and body mass index. Pediatrics. 2000; 106(1):52. [PubMed: 10878149]
40. Pietiläinen KH, Kaprio J, Borg P, Plasqui G, Yki-Jäevinen H, Kujala UM, et al. Physical inactivity and obesity: a vicious circle. Obesity. 2008; 16:409–414. [PubMed: 18239652]

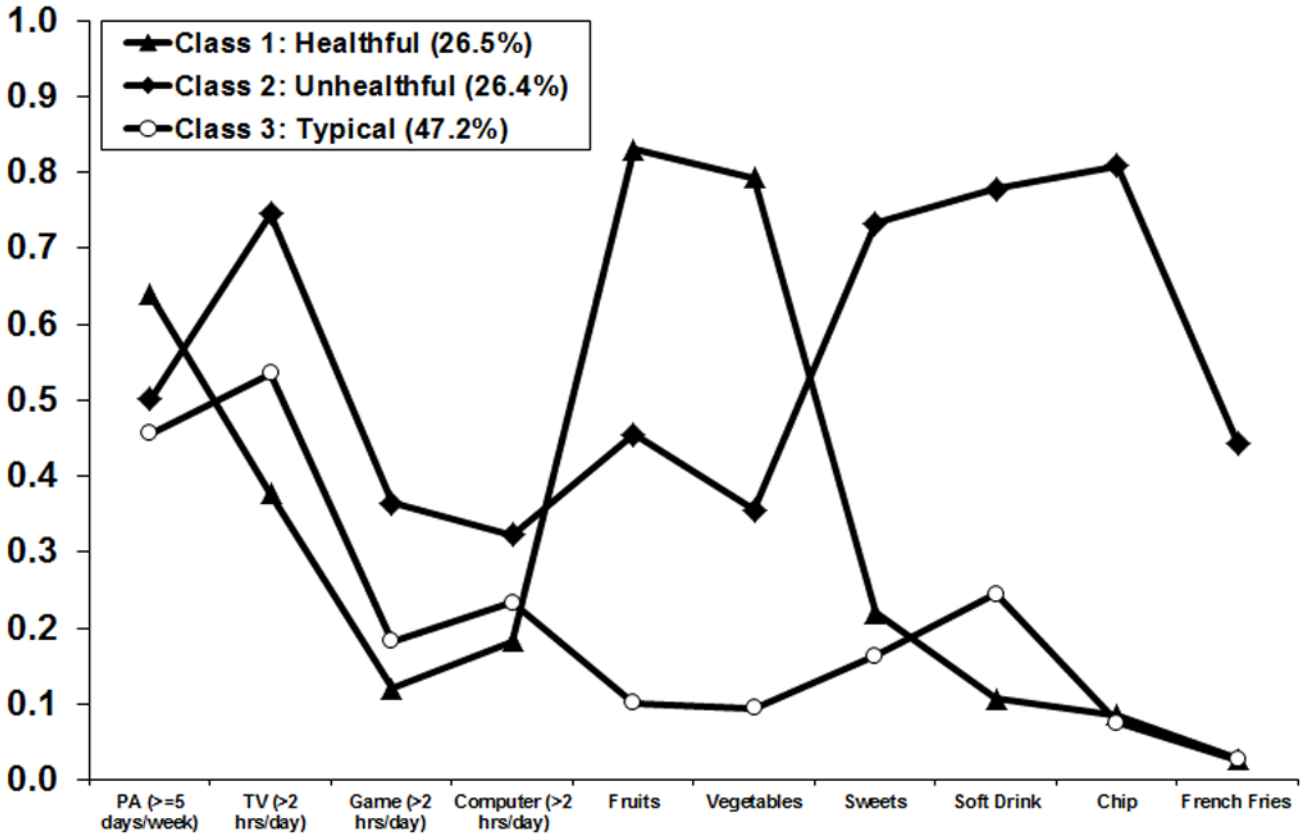

Figure 1.
Item Probability: Involvement in Each Health Behavior for Each Latent Class
Note. The cut-off for each dietary behavior was >=once/day.

Table 1

Descriptive Statistics for Latent Class Indicators By Gender

	Total *N* = 9,206	**Male *N* = 4,455**	**Female *N* = 4,750**	**p-value (Gender)**
Categorical Variables	% (SE)	% (SE)	% (SE)	
PA (>=5 days/week)	51.7 (1.40)	60.3 (1.39)	43.4 (1.60)	<.0001
TV (>2 hrs/day)	54.8 (1.50)	53.5 (1.69)	56.1 (1.69)	.093
Video Game (>2 hrs/day)	21.3 (0.88)	29.9 (1.40)	13.1 (0.69)	<.0001
Computer (>2 hrs/day)	24.3 (1.15)	20.4 (1.21)	28.1 (1.46)	<.0001
Daily Food intake (>= once/day)				
Fruits	38.7 (1.12)	37.3 (1.26)	40.1 (1.40)	.053
Vegetables	34.7 (0.96)	33.4 (1.46)	36.0 (1.04)	.105
Sweets	32.7 (1.21)	29.1 (1.20)	36.2 (1.52)	<.0001
Sweetened Soft Drink	34.9 (1.34)	36.3 (1.30)	33.5 (1.60)	.022
Chips	27.1 (1.53)	26.9 (1.40)	27.3 (1.86)	.773
French Fries	13.7 (0.79)	14.3 (0.95)	13.1 (0.90)	.245

Note. Percentages were weighted percentages by adjusting for the survey design including stratification, clustering and weighting. p-values are for test of gender differences.

Table 2

Model Fit Statistics of the 1- to 5-class LCA models

	Number of Classes				
All (N = 9,206)	**1**	**2**	**3**	**4**	**5**
Loglikelihood	−54721.1	−52011.1	−50979.0	−50766.8	−50591.4
Information Criteria					
N of Free Parameters	10	21	32	43	54
Akaike (AIC) [a]	109462.2	104064.1	102022.0	101619.6	101290.7
Bayesian (BIC) [b]	109533.4	104213.8	102250.1	101926.1	101675.6
Sample-Size ABIC	109501.7	104147.1	102148.4	101789.5	101504.0
ACPs [c]	--	.893–.940	.827–.879	.801–.843	.652–.807
Male (N = 4,455)	1	2	3	4	5
Loglikelihood	−26403.9	−25176.1	−24676.3	−24553.8	−24449.9
Information Criteria					
N of Free Parameters	10	21	32	43	54
Akaike (AIC) [a]	52827.8	50394.2	49416.5	49193.7	49007.7
Bayesian (BIC) [b]	52891.8	50528.6	49621.4	49468.9	49353.4
Sample-Size ABIC	52860.1	50461.9	49519.7	49332.3	49181.8
ACPs [c]	--	.893–.938	.835–.879	.811–.855	.653–.847
Female (N = 4,740)	1	2	3	4	5
Loglikelihood	−27839.2	−26326.6	−25776.4	−25645.4	−25543.9
Information Criteria					
N of Free Parameters	10	21	32	43	54
Akaike (AIC) [a]	55698.4	52695.2	51616.7	51376.8	51195.8
Bayesian (BIC) [b]	55763.1	52830.9	51823.6	51654.7	51544.8
Sample-Size ABIC	55731.3	52764.2	51721.9	51518.1	51373.2
ACPs [c]	--	.893–.942	.843–.888	.877	.763–.861

Note.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

[a]AIC = Akaike's Information Criteria;

[b]BIC = Bayesian Information Criteria; Sample-Size ABIC = Sample-size adjusted BIC; ACPs = Average Latent Class Probabilities for Most Likely Latent Class Membership.

Table 3

Results of LCA with Covariates: Demographic Differences

	All (N = 8,982)		Male (N = 4,323)		Female (N = 4,659)	
	OR	**[95% C.I.]**	**OR**	**[95% C.I.]**	**OR**	**[95% C.I.]**
Class 2 (Unhealthful) [a]						
Female [b]	0.87	[0.73–1.04]	--	--	--	--
Age	1.06	[0.96–1.17]	1.06	[0.95–1.19]	1.04	[0.91–1.19]
Race/Ethnicity [b]						
African-American	**10.5**	**[6.32–17.4]**	**6.84**	**[4.02–11.7]**	**15.7**	**[8.29–29.8]**
Hispanic	**2.96**	**[2.15–4.09]**	**2.28**	**[1.41–3.68]**	**3.71**	**[2.47–5.56]**
Other	**1.74**	**[1.23–2.46]**	**1.64**	**[1.09–2.47]**	**1.87**	**[1.19–2.92]**
FAS[c]	**0.83**	**[0.77–0.89]**	**0.87**	**[0.78–0.97]**	**0.79**	**[0.72–0.87]**
Class 3 (Typical) [a]						
Female [b]	**0.79**	**[0.63–0.99]**	--	--	--	--
Age	**1.18**	**[1.09–1.26]**	**1.20**	**[1.10–1.30]**	**1.14**	**[1.03–1.27]**
Race/Ethnicity [b]						
African-American	**2.36**	**[1.56–3.57]**	1.49	[0.92–2.39]	**3.60**	**[1.88–6.89]**
Hispanic	**1.64**	**[1.22–2.23]**	1.42	[0.99–2.03]	**1.86**	**[1.15–2.99]**
Other	1.02	[0.65–1.58]	0.82	[0.52–1.30]	1.29	[0.79–2.11]
FAS[c]	**0.83**	**[0.78–0.88]**	**0.90**	**[0.83–0.97]**	**0.76**	**[0.70–0.84]**

Note. Significant odds ratios are in bold print.

[a]The latent class of *Healthful* was set as the reference group for the multinomial logistic regression model;

[b]For gender and race/ethnicity, the reference groups were male and Caucasian adolescents.

[c]High Family Affluence Scale scores was the referent for FAS.

Table 4

Comparing Weight Status, Losing Weight Behaviors, Depression and Frustration of Physical Appearance across Latent Classes

	All				Male				Female			
Categorical Variables	**Overall**	**Class 1**	**Class 2**	**Class 3**	**Overall**	**Class 1**	**Class 2**	**Class 3**	**Overall**	**Class 1**	**Class 2**	**Class 3**
	%	%	%	%	%	%	%	%	%	%	%	%
Weight Status												
Underweight	3.7	**3.9**^{ab}	**4.9**^{a}	**3.0**^{b}	4.3	**4.3**^{ab}	**5.8**^{a}	**3.6**^{b}	3.2	**3.6**^{ab}	**4.0**^{a}	**2.5**^{b}
Normal	65.5	**67.9**^{a}	**65.2**^{ab}	**64.3**^{b}	61.9	62.9	62.2	61.2	69.0	**72.2**^{a}	**68.3**^{b}	**67.5**^{b}
Overweight	17.1	**15.8**^{a}	**16.3**^{ab}	**18.4**^{b}	18.3	17.5	17.3	19.3	16.0	**14.3**^{a}	**15.2**^{ab}	**17.4**^{b}
Obese	13.6	12.4	13.6	14.4	15.4	15.3	14.7	15.9	11.9	**9.9**^{a}	**12.5**^{b}	**12.7**^{b}
Losing Weight												
No, my weight is fine	47.3	**48.3**^{a}	**50.6**^{a}	**44.9**^{b}	54.2	**53.0**^{a}	**59.3**^{b}	**52.2**^{a}	40.7	**44.5**^{a}	**42.4**^{a}	**37.5**^{b}
No, but I should lose some weight	22.6	**19.3**^{a}	**21.6**^{a}	**25.1**^{b}	16.7	**13.6**^{a}	**15.3**^{a}	**19.1**^{b}	28.3	**24.2**^{a}	**27.8**^{b}	**31.0**^{b}
No, because I need to put on weight	7.8	**6.5**^{a}	**10.1**^{b}	**7.3**^{a}	10.8	11.0	11.8	10.3	4.9	**2.5**^{a}	**8.3**^{c}	**4.2**^{b}
Yes	22.2	**25.9**^{a}	**17.7**^{c}	**22.8**^{b}	18.2	**22.4**^{a}	**13.6**^{c}	**18.4**^{b}	26.1	**28.9**^{a}	**21.5**^{b}	**27.3**^{a}
Continuous Variables	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Body Dissatisfaction (n=7,844)	2.20	**2.14**^{a}	**2.14**^{a}	**2.27**^{b}	1.94	**1.88**^{a}	**1.87**^{a}	**2.00**^{b}	2.45	**2.37**^{a}	**2.39**^{a}	**2.53**^{b}
Physical Symptoms (n=9,101)	1.96	**1.89**^{a}	**2.11**^{b}	**1.91**^{a}	1.78	**1.71**^{a}	**1.93**^{b}	**1.75**^{a}	2.13	**2.04**^{a}	**2.29**^{b}	**2.08**^{a}
Depression (n=9,058)	2.41	**2.27**^{a}	**2.56**^{c}	**2.40**^{b}	2.20	**2.11**^{a}	**2.35**^{c}	**2.17**^{b}	2.61	**2.40**^{a}	**2.76**^{c}	**2.64**^{b}
Life Satisfaction (n=9,064)	7.37	**7.67**^{a}	**7.27**^{b}	**7.25**^{b}	7.46	**7.70**^{a}	**7.38**^{b}	**7.38**^{b}	7.28	**7.67**^{a}	**7.16**^{b}	**7.12**^{b}
Overall Health (n=9,092)	2.95	**3.09**^{a}	**2.92**^{b}	**2.88**^{b}	3.06	**3.17**^{a}	**3.07**^{b}	**2.99**^{c}	2.84	**3.03**^{a}	**2.78**^{b}	**2.78**^{b}

Note. Class 1: *Healthful* pattern; Class 2: *Unhealthful* pattern; Class 3: *Typical* pattern.

^{a,b,c}Values with same superscript were not significantly different from each other.

"Body dissatisfaction" was asked for all adolescents in grades 7 to 10 and half of adolescents in grade 6.