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R H. Striegel
rstriegel@wesleyan.edu

L D. Ritchie

P Spector

M J. Stevens

M M. Schmidt

See next page for additional authors

Authors
R H. Striegel, L D. Ritchie, P Spector, M J. Stevens, M M. Schmidt, G B. Schreiber, M C. Wang, and P B. Crawford

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Dietary Patterns in Adolescence Are Related to Adiposity in Young Adulthood in Black and White Females[1,2]

Lorrene D. Ritchie,[3]* Phil Spector,[3] Mary J. Stevens,[4] Marcia M. Schmidt,[5] George B. Schreiber,[6] Ruth H. Striegel-Moore,[7] May-Choo Wang,[3] and Patricia B. Crawford[3]

[3]The Center for Weight and Health, College of Natural Resources and School of Public Health, University of California, Berkeley, CA 94720; [4]The Nutrition Coordinating Center, University of Minnesota, Division of Epidemiology, Minneapolis, MN 55454; [5]Children's Hospital Medical Center, Cincinnati, OH 45229; [6]Westat, Inc., Rockville, MD 20850; and [7]Department of Psychology, Wesleyan University, Middletown, CT 06549

Abstract

Few studies have systematically used a total diet approach to classify adolescent dietary patterns. We examined dietary patterns in relation to nutrient intakes and adiposity in the National Heart, Lung, and Blood Institute Growth and Health Study cohort of 2371 black and white girls recruited at 9–10 y of age and followed for 10 y. Serial measurements were obtained for indices of anthropometry, dietary intake, physical activity, and sociodemographic variables. Dietary patterns for the 2 racial subgroups were separately identified by cluster analysis of 40 food groupings derived from 3-d food records. Nutrient intakes and measures of adiposity (BMI, percent body fat, and waist circumference) were compared by dietary pattern. We identified 4 discrete dietary patterns for black and for white adolescents. A Healthy pattern, followed by 12% of white girls and characterized by a high intake of fruits, vegetables, dairy, grains without added fats, mixed dishes and soups, and a low intake of sweetened drinks, other sweets, fried foods, burgers, and pizza, was related to more favorable nutrient intakes and a smaller increase in waist circumference. Among black girls, none of the dietary patterns appeared distinctly advantageous in terms of mitigating increases in adiposity. In conclusion, a cumulative pattern of food intake consistent with recommendations for general health appears to help prevent overweight, but this pattern was followed by only a minority of adolescent girls. J. Nutr. 137: 399–406, 2007.

Introduction

Countless studies have examined the relation between intake of individual nutrients or foods and risk of energy imbalance and obesity (1). Foods are eaten in distinct and identifiable patterns, which can be used to classify individuals (2). However, relatively few longitudinal studies have systematically evaluated the relation of overall dietary patterns to obesity risk. Examination of overall dietary patterns is conceptually appealing in that it mimics the way in which people eat, consuming meals and snacks consisting of a variety of foods, rather than as isolated nutrients or distinct ingredients (3). Both factor analysis and cluster analysis are valid methods for assessing dietary patterns. Dietary pattern methodology has been validated in studies of adults by establishing consistency between patterns of dietary intake and both nutrient intake and biological and behavioral risk factors (3,4).

We recently completed a comprehensive review of the literature on dietary patterns in relation to adiposity involving 2 longitudinal studies, 2 nationally representative studies, and 20 cross-sectional or case-control studies (1). Although results were not entirely consistent across all studies, the preponderance of evidence suggested that a "Western" dietary pattern, characterized by a predominance of high-fat foods (i.e. high-fat meat and dairy, fats, and oils), refined grains, and sweetened drinks and other added sugars, was related to increased adiposity. Conversely, a dietary pattern characterized by a high intake of lower fat foods, whole grains, fruits, vegetables, and legumes appeared to be protective against overweight.

Unfortunately, most studies of dietary patterns in relation to obesity have been cross-sectional in design. It is possible that the fact that not all studies detected differences in adiposity according to diet pattern can be attributed to changes in diet adopted by overweight individuals attempting to lose weight or avoid further weight gain (5). Another limitation is that the focus of most studies of dietary patterns has been on older white adults. No studies were identified that examined dietary patterns

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* To whom correspondence should be addressed. E-mail: lorrene_ritchie@sbcglobal.net.

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of children or adolescents exclusively in relation to measures of adiposity. The only study that included children, and incidentally 1 of the few studies of non-white subjects (6), did not disaggregate the data by age. Further, many of the dietary pattern studies were not designed specifically to assess the relation between patterns of intake and adiposity and frequently relied upon self-reported heights and weights. Clearly, additional well-conducted prospective studies including a racially diverse sample of youth are warranted.

The primary aims of this investigation were to identify dietary patterns using cluster analysis and to determine the relation of dietary patterns with nutrient intakes and measures of adiposity using data from the 10-y longitudinal study of adolescent nutrition and cardiovascular health in black and white girls, the NHLBI Growth and Health Study (NGHS). We hypothesized that dietary patterns would differ in nutrient content and that certain patterns would be associated with increased adiposity in young adulthood.

Materials and Methods

Participants. The NGHS has been described in detail elsewhere (7). Briefly, this multi-center longitudinal study began in 1987 with a cohort of 2379 girls (1213 black and 1166 white), 9 and 10 y of age, and continued through 10 y of annual data collection. Girls were recruited by 1 of 3 clinical centers: the University of California at Berkeley; Cincinnati Children's Hospital Medical Center, Ohio; and Westat in Rockville, Maryland. Written informed consent was obtained from all participants and from their parents or guardians. The NGHS study was approved by the institutional review boards at each site. Inclusion criteria at enrollment consisted of the following: within 2 wk of age 9 or 10 y at the time of the first clinic visit, black or white (by self-report), living with parents/guardians with racial concordance, and parent/guardian providing information on the demographics of the household as well as consent for the girl's participation.

Detailed information was collected from participants on medical history, eating behaviors, dietary intake, physical activity, sedentary behaviors, anthropometric measurements, blood pressure, blood lipids, health beliefs and attitudes, and a range of psychosocial variables. Participants' parents or guardians also provided information on household demographics. For the purposes of this analysis, only girls who had dietary information collected during each of 3 stages of adolescence (ages 9–11 y, 12–14 y, and 15–19 y) were included. This resulted in the exclusion of 2 black girls and 6 white girls for a total sample of 2371.

Assessment of adiposity. Anthropometric measures were made annually using standardized protocols, as described previously (7). These included height and weight (from which BMI was derived), percent body fat using sum of skinfolds, and waist circumference measured at the umbilicus. Light clothing was provided for girls to wear during anthropometric measurements.

Dietary assessment. Once each year (except study years 6 and 9), girls recorded dietary intake for 3 d (2 weekdays, 1 weekend day) using measuring cups, spoons, and rulers, as previously described (8). All girls were trained on recording dietary intakes and provided guidance from a nutritionist who met with subjects to clarify food preparation methods, brand names of foods, and portion sizes. Food records were coded using University of Minnesota Nutrition Coordinating Center software according to discrete foods or ingredients to derive a nutrient-based database.

Reformulation of dietary intake as whole foods. The Nutrition Coordinating Center constructed a comprehensive food-based database using NGHS data by transforming discrete foods and ingredients back into combined foods (i.e. the way in which foods were consumed) (9). For example, in the original nutrient-based database, a hamburger was coded into component parts such as meat patty, bun, lettuce, onion, pickle, tomato, catsup, mayonnaise, and so forth. In the transformed database, a hamburger is coded as a sandwich including all of its component ingredients; the small servings of vegetables and condiments are not coded separately from the meat and grains. In this way, patterns based on the intake of whole foods, rather than separate ingredients, could be examined.

Identification of dietary patterns. In coordination with an advisory panel of experts on dietary assessment and dietary patterns,[4] the hundreds of different foods consumed by NGHS participants were combined into 40 food groupings (suitable for analytical purposes) based on frequency of usage, contribution to total energy intake, and customary use in the diet (**Supplemental Table 1**). Factor analysis, an analytical technique used to group foods into patterns, was used to check for any additional structure in the variables beyond that implied by the food groupings; none were revealed, validating the selection of the 40 food groupings. Having done this, we then used cluster analysis of the 40 food groupings to achieve our original objective, to identify individuals whose patterns of food grouping intake were similar.

To adjust for weight differences between solid and liquid foods combined within a food grouping and eliminate clustering around foods with the greatest weight, intakes of individual foods (recorded in units of gram weight) were converted to Z-scores and then summed within each food grouping. For each girl, Z-scores for each of the 40 food groupings were first averaged across the 3 d of diet records and then over the 8 y of dietary data collection. Hierarchical cluster analysis using Ward's distance was then performed on the amount consumed (mean Z-score for g/d) of the 40 food groupings with 4 clusters requested in modeling. Analyses with larger numbers of cluster solutions were examined, but these tended to result in further splitting of the smaller groups and were not more informative. Because food groupings differed between black and white girls, separate cluster analyses were performed for each subgroup. Using this approach, each individual was assigned to a single cluster based on dietary records aggregated over the course of the 10-y study. For ease of discussion, each dietary pattern was designated by a descriptive name based on predominant food groupings (largest or smallest amount relative to the other patterns).

Computing nutrient intakes. Nutrient intakes were derived as previously described (10). Means for macronutrients, micronutrients, and other dietary components were first averaged across the 3 d of diet records for each participant for each study year, then across all study years for each participant, and then for all participants in each of the 4 dietary patterns by subgroup (blacks and whites). In computing these means, nutrients consumed only in the form of foods or beverages were counted; vitamin and/or mineral supplements were not included. Nutrient totals were adjusted for total energy intakes (kcal; 1 kcal = 4.184 kJ) to emphasize the nutrient density of the diet. Nutrient totals per 2000 kcal were presented to provide an estimate of total nutrient intake, as the mean energy intake for participants approximated 2000 kcal.

Statistical analysis. Values in the text are means ± SEM. Mean intakes of food groupings and nutrients were compared by race using *t* tests. ANOVA was also used to compare nutrient intakes (averaged over the 10-y study) and to compare measures of adiposity (year 1, baseline; year 10, final follow-up; and change between baseline and final follow-up) between dietary patterns for each race subgroup. Control variables included in the adiposity comparisons were selected on the basis of being related to both the independent variable (dietary pattern) and dependent

[4] Gladys Block, School of Public Health, University of California, Berkeley, CA; Bette Caan, Division of Research, Kaiser Permanente, Oakland, CA; Catherine Champagne, Pennington Biomedical Research Center, Baton Rouge, LA; Lori Beth Dixon, Department of Nutrition, Food Studies and Public Health, New York University, NY; Suzanne Murphy, Cancer Research Center, University of Hawaii, HI; Marcia Schmidt, Cincinnati Children's Hospital Medical Center, OH; Mary Stevens, Nutrition Coordinating Center, University of Minnesota, MN; Phyllis Stumbo, Clinical Research Center, University of Iowa, IA; Doug Taren, College of Public Health, University of Arizona, AZ.

variables (adiposity measures) and included corresponding baseline measure of adiposity, age of menarche, ever pregnant over the course of the 10-y study, maximal parental education (highest level of school completed by a parent), perceived physical activity frequency (dichotomized as never/almost never/sometimes or usually/always), and TV/video watching (h/d). Mean nutrient intakes for each dietary pattern were compared separately for blacks and whites using the Student-Newman-Keuls (SNK) pairwise multiple comparison procedure. Analyses were done using SAS/STAT software, Version 9.1.3 of the SAS System for Linux (SAS Institute) and R software, Version 2.3.0 (R: A Language and Environment for Statistical Computing). Differences were considered significant at $P < 0.05$.

Results

Differences in intake of food groupings by race. Mean intakes (averaged over the course of the 10-y study) for the 40 food groupings were similar between black and white girls for only 6 food groupings: plain breads (breads without additions such as butter); plain grains (grains without additions); cereal; nuts/popcorn; fish/poultry (not fried); and pizza (**Supplemental Table 2**). Compared with whites, blacks had significantly greater mean intakes of 16 food groupings: sweetened drinks; juice; other breakfast grains; baked desserts; other desserts; candy; chips; eggs; fried fish/poultry; red meat; processed meats/sandwiches; burger sandwiches; ramen; legumes; other vegetables; and fried potatoes. Compared with blacks, whites had significantly greater mean intakes of 18 food groupings: coffee/tea; diet drinks; plain milk; flavored milk; yogurt; cheese; ice cream; sweet rolls; crackers; pretzels; other meat sandwiches; peanut butter sandwiches; cheese/spread sandwiches; mixed dishes; other soups; fruit; green salad; and potatoes (not fried).

Food groupings characteristic of dietary patterns. A Customary pattern was followed by 53% of black girls (**Table 1**). Relative to other dietary patterns identified among black girls, the Customary pattern was characterized by a comparatively low intake of diet drinks, coffee/tea, yogurt, cheese, plain grains, crackers, fish/poultry (not fried), red meat, other soups, and most vegetables. General intake of many food groupings was the hallmark of this pattern. Less than one-quarter (23%) of black girls followed a Snack-type foods pattern, characterized by relatively high intakes of diet drinks, coffee/tea, yogurt, crackers, pretzels, other soups, and green salad, and low intakes of flavored milks, several other grain groupings, and processed meats/sandwiches. Another 22% of black girls followed a Meal-type foods pattern, which was characterized by relatively high intakes of plain breads and grains, other breakfast grains, and most types of sandwiches and protein sources, including legumes. Other vegetables and fried and not fried potatoes were also highly consumed by girls following this pattern. The final group, referred to as the Sweets and cheese pattern, was followed by a minority of girls (<2%) who tended to consume relatively large amounts of sweets, flavored milk and cheese, and relatively small amounts of many other groups, most notably eggs, fried fish/poultry, and fried potatoes.

Among white girls, the most predominant pattern (followed by 45% of white girls) was referred to as the Convenience pattern (**Table 2**). This pattern was characterized by relatively high intakes of pizza, fried fish and poultry, and ramen, and relatively low intakes of juice, plain milk, many of the grain-type groupings, eggs, not fried fish and poultry, cheese/spread sandwiches, other soups, fruit, and most of the vegetable-rich groupings. One-third of white girls followed a Sweets and snack-type foods pattern characterized by relatively high intakes of sweetened and diet drinks, juice, cheese, other desserts, candy, crackers, pretzels, nuts/popcorn, peanut butter and cheese/spread sandwiches, and relatively low intakes of flavored milk, processed meats/sandwiches, and mixed dishes. The third pattern, referred to as a Fast food pattern, followed by 10% of white girls, was relatively high in flavored milk, burger sandwiches, fried potatoes, eggs, red meat, processed meats/sandwiches, chips, legumes, and baked desserts. This pattern was relatively low in diet drinks, yogurt, cheese, other desserts, candy, crackers, pretzels, and peanut butter sandwiches. The final pattern, called Healthy, followed by 12% of white girls, was characterized by a relatively low intake of sweetened drinks, baked desserts, chips, fried fish/poultry, red meat, burgers, pizza, and fried potatoes. Relatively highly consumed were plain milk, yogurt, plain breads and grains (without added fats or condiments), cereal and other breakfast grains, mixed dishes, other soups, fruit, green salad, not fried potatoes, and other vegetables.

Nutrient intakes by dietary pattern. Among black girls, energy, saturated fat, sucrose, and calcium intakes were highest for the Sweets and cheese pattern ($P < 0.05$). Cholesterol intake was significantly higher for the Meal-type foods pattern compared with other patterns (**Table 3**). The Meal-type foods pattern was characterized by higher intakes of most vitamins and minerals, although these differences were not significant. Mean intakes for all of the patterns were above Dietary Reference Intake guidelines of 20 to 35% of energy from total fat (with means ranging from 35.6 ± 0.2% of energy from total fat for the Snack-type foods pattern to 36.6 ± 0.2% of energy from total fat for the Meal-type foods pattern) and <10% of energy from saturated fat (with means ranging from 12.6% ± 0.1% of energy from saturated fat for the Snack-type foods pattern to 13.4 ± 0.3% of energy from saturated fat for the Sweets and cheese pattern).

Among white girls, the Fast food pattern was characterized by the highest intake of energy, fat, cholesterol, saturated fat, monounsaturated fat, and sodium and the lowest intake of dietary fiber and most vitamins and minerals (**Table 4**). The Healthy pattern was characterized by the lowest total fat, saturated fat, and monounsaturated fat as a percentage of energy intake and the highest intake of dietary fiber and all vitamins and minerals assessed, except sodium. The Convenience and Sweets and snack-type foods patterns tended to be intermediate in nutrient intakes between the Fast food and Healthy patterns, although the Convenience pattern was lowest for total energy and vitamin C intakes and the Sweets and snack-type foods pattern was lowest for cholesterol and sodium intakes and highest for total carbohydrate and sucrose intakes.

Measures of adiposity by dietary pattern. For black girls, mean BMI, percent body fat, and waist circumference at final follow-up (study year 10, age 18–19 y) did not differ significantly for blacks by dietary pattern, after adjusting for baseline BMI, age of menarche, pregnancy, parental education, physical activity, TV/video watching (**Table 5**). However, black girls following the Sweets and cheese pattern tended to have the largest values for the adiposity measures ($P = 0.095$ for percent body fat for the Sweets and cheese vs. Snack-type foods patterns) and black girls following the Meal-type pattern tended to have the lowest values ($P = 0.074$ for waist circumference for the Meal-type vs. the Customary pattern).

Among white girls, after adjusting for potential confounders, those following the Healthy pattern exhibited significantly smaller

TABLE 1 Dietary patterns identified for black girls based on mean consumption of 40 food groupings[1]

Food grouping	Customary, $n = 643$	Snack-type foods, $n = 276$	Meal-type foods, $n = 269$	Sweets and cheese, $n = 23$
			g/d	
Sweetened drinks	460.4 ± 5.5	509.1 ± 8.6	485.7 ± 9.3	469.0 ± 32.7
Diet drinks	12.8 ± 1.0[b]	38.1 ± 3.9[a]	19.5 ± 2.2[b]	17.5 ± 4.7[b]
Juice	131.3 ± 3.3	147.6 ± 5.1	156.1 ± 5.4	161.5 ± 16.1
Coffee and tea	23.5 ± 1.6[b]	62.0 ± 5.1[a]	40.7 ± 3.8[b]	31.9 ± 11.7[b]
Plain milk	108.6 ± 3.5	92.3 ± 4.6	118.4 ± 5.5	106.8 ± 18.3
Flavored milk	65.9 ± 2.4[ab]	54.2 ± 3.4[b]	60.6 ± 3.9[ab]	81.6 ± 13.0[a]
Yogurt	4.3 ± 0.4[b]	14.9 ± 1.7[a]	4.9 ± 0.7[b]	12.1 ± 5.5[a]
Cheese	0.8 ± 0.1[b]	1.2 ± 0.2[b]	0.8 ± 0.2[b]	26.6 ± 3.0[a]
Ice cream	47.2 ± 1.8	50.2 ± 2.7	46.7 ± 2.4	53.1 ± 9.6
Plain breads	12.4 ± 0.4[b]	12.3 ± 0.6[b]	19.0 ± 1.0[a]	16.7 ± 2.9[ab]
Plain grains	12.3 ± 0.8[b]	16.5 ± 1.5[b]	25.8 ± 2.7[a]	14.1 ± 4.1[b]
Cereal	82.8 ± 2.0	68.7 ± 3.1	89.4 ± 3.8	77.4 ± 7.3
Other breakfast grains	9.7 ± 0.5[b]	9.4 ± 0.7[b]	15.0 ± 1.1[a]	10.5 ± 3.0[b]
Sweet rolls	7.6 ± 0.4	7.7 ± 0.6	7.0 ± 0.6	6.5 ± 1.5
Baked desserts	28.8 ± 0.9	26.2 ± 1.0	29.2 ± 1.2	30.0 ± 4.6
Other desserts	16.0 ± 1.5	22.0 ± 2.3	21.2 ± 2.0	29.3 ± 8.1
Candy	17.4 ± 0.7	15.8 ± 0.8	16.9 ± 0.9	17.5 ± 2.7
Crackers	3.8 ± 0.2[b]	6.5 ± 0.6[a]	4.5 ± 0.4[ab]	6.0 ± 1.0[ab]
Chips	10.4 ± 0.3	10.4 ± 0.4	12.5 ± 0.6	11.5 ± 1.6
Pretzels	0.5 ± 0.1[b]	3.8 ± 0.4[a]	0.6 ± 0.1[b]	0.7 ± 0.4[b]
Nuts and popcorn	8.2 ± 0.5	7.0 ± 0.5	6.2 ± 0.5	8.8 ± 1.9
Eggs	13.3 ± 0.5[b]	13.6 ± 0.7[b]	19.3 ± 1.0[a]	12.5 ± 2.5[b]
Fish and poultry (not fried)	10.7 ± 0.5[b]	15.3 ± 0.9[ab]	20.1 ± 1.3[a]	14.5 ± 2.4[ab]
Fried fish and poultry	21.6 ± 0.6[b]	24.9 ± 1.0[b]	32.4 ± 1.6[a]	21.4 ± 2.8[b]
Red meat	20.2 ± 0.8[b]	22.5 ± 1.3[b]	40.3 ± 2.0[a]	21.3 ± 3.6[b]
Processed meats and sandwiches	44.6 ± 0.8[b]	41.4 ± 1.3[b]	55.6 ± 1.9[a]	54.0 ± 8.2[a]
Burger sandwiches	19.8 ± 0.7	20.5 ± 1.1	20.8 ± 1.1	19.0 ± 2.9
Other meat sandwiches	8.4 ± 0.3	10.1 ± 0.7	9.5 ± 0.6	10.9 ± 2.3
Peanut butter sandwiches	3.5 ± 0.3	3.3 ± 0.3	2.4 ± 0.3	3.4 ± 1.0
Cheese and spread sandwiches	11.4 ± 0.4	11.8 ± 0.5	13.2 ± 0.6	10.7 ± 2.0
Mixed dishes	58.5 ± 1.6	67.5 ± 2.6	71.3 ± 3.0	70.9 ± 7.8
Pizza	24.0 ± 0.9	20.9 ± 1.2	21.3 ± 1.4	22.3 ± 3.9
Ramen	35.2 ± 2.4	21.3 ± 2.3	31.2 ± 3.4	27.6 ± 10.0
Other soups	19.3 ± 1.3[b]	57.0 ± 4.5[a]	31.2 ± 3.1[b]	34.0 ± 8.8[b]
Fruit	59.3 ± 2.0	75.6 ± 3.4	77.3 ± 3.5	72.2 ± 10.1
Green salad	5.8 ± 0.3[b]	12.0 ± 0.8[a]	7.0 ± 0.5[b]	11.7 ± 1.7[a]
Legumes	12.7 ± 0.9[b]	16.3 ± 1.4[b]	32.0 ± 3.1[a]	29.1 ± 7.3[a]
Other vegetables	31.3 ± 1.0[b]	33.0 ± 1.5[b]	53.6 ± 2.4[a]	33.6 ± 5.0[b]
Potatoes (not fried)	13.3 ± 0.6[b]	15.5 ± 1.1[b]	27.0 ± 2.1[a]	17.2 ± 3.8[b]
Fried potatoes	27.5 ± 0.8[b]	29.5 ± 1.1[b]	36.1 ± 1.6[a]	26.7 ± 3.0[b]

[1] Values are means ± SEM. Means in a row with superscripts without a common letter differ, $P < 0.05$, adjusted for multiple comparisons (SNK test).

mean values for waist circumference at the final follow-up and in change in waist circumference (study year 10 to year 1) compared with the Sweets and snack-type foods pattern ($P = 0.037$). Girls following the Healthy pattern also tended to have lower values for body fat ($P = 0.063$ for percent body fat for the Healthy vs. Fast food patterns).

Discussion

Identifying typical patterns of food intake and determining their relation to health outcomes may help us understand disparities in obesity. The intake of nearly all of the 40 food groupings included in our analyses and the dietary patterns identified differed for black and white teens in the NGHS cohort. As a whole, the dietary patterns among the black teens were more homogeneous than for the white teens. Essentially only 3 main patterns emerged among the black girls with over one-half of the black girls followed a single dietary pattern, referred to as the Customary pattern, and only a relatively small minority following the Sweets and cheese pattern. Further, the patterns identified for the black girls differed significantly on the basis of only one-half of the 40 distinct food groupings and on only a few of the measured nutrients. In contrast, more distinct dietary patterns emerged among the white adolescents. The dietary patterns for whites differed significantly from each other on the basis of a majority of food groupings and quantified nutrients. Further, relative to recommended intakes, all of the patterns

TABLE 2 Dietary patterns identified for white girls based on mean consumption of 40 food groupings[1]

Food grouping	Convenience, $n = 521$	Sweets and snack-type foods, $n = 380$	Fast food, $n = 118$	Healthy, $n = 141$
		g/d		
Sweetened drinks	367.4 ± 6.2[a]	396.9 ± 6.9[a]	396.0 ± 14.8[a]	287.5 ± 11.5[b]
Diet drinks	67.5 ± 3.7[ab]	87.2 ± 5.2[a]	59.5 ± 8.2[b]	66.1 ± 7.4[ab]
Juice	104.1 ± 3.1[b]	160.4 ± 4.4[a]	146.7 ± 8.2[a]	149.7 ± 7.4[a]
Coffee and tea	42.7 ± 3.1	60.7 ± 4.3	43.9 ± 6.4	55.5 ± 5.3
Plain milk	176.7 ± 4.5[b]	186.9 ± 5.6[ab]	203.9 ± 9.4[a]	209.2 ± 10.0[a]
Flavored milk	72.2 ± 2.8[b]	57.7 ± 2.9[b]	90.3 ± 8.0[a]	59.3 ± 5.1[b]
Yogurt	16.7 ± 1.2[bc]	22.5 ± 1.4[b]	11.6 ± 1.7[c]	50.1 ± 4.1[a]
Cheese	3.5 ± 0.3[b]	9.1 ± 0.8[a]	2.5 ± 0.6[b]	7.2 ± 0.9[a]
Ice cream	53.6 ± 1.9	55.2 ± 2.2	56.9 ± 4.2	51.1 ± 3.5
Plain breads	10.9 ± 0.5[c]	16.1 ± 0.7[b]	11.6 ± 1.2[c]	23.1 ± 2.0[a]
Plain grains	10.2 ± 0.8[b]	15.2 ± 1.2[b]	10.5 ± 1.8[b]	36.3 ± 4.1[a]
Cereal	81.7 ± 2.3	78.7 ± 2.4	80.2 ± 5.4	84.1 ± 3.8
Other breakfast grains	6.6 ± 0.3[b]	10.3 ± 0.7[a]	9.8 ± 1.2[a]	11.1 ± 1.1[a]
Sweet rolls	10.5 ± 0.6	11.4 ± 0.6	9.2 ± 1.0	10.0 ± 1.0
Baked desserts	23.2 ± 0.7[ab]	23.0 ± 0.8[ab]	26.8 ± 1.9[a]	22.0 ± 1.3[b]
Other desserts	11.8 ± 0.9[b]	22.1 ± 1.8[a]	10.6 ± 1.9[b]	14.9 ± 2.1[b]
Candy	13.2 ± 0.5[b]	16.8 ± 0.7[a]	12.3 ± 1.1[b]	12.4 ± 0.7[b]
Crackers	5.7 ± 0.3[b]	10.5 ± 0.5[a]	4.9 ± 0.6[b]	9.0 ± 0.8[a]
Chips	8.3 ± 0.3[b]	8.2 ± 0.3[b]	9.9 ± 0.9[a]	6.5 ± 0.6[c]
Pretzels	2.8 ± 0.2[b]	6.9 ± 0.5[a]	2.0 ± 0.4[b]	3.5 ± 0.6[b]
Nuts and popcorn	5.5 ± 0.3[b]	8.6 ± 0.4[a]	6.8 ± 1.2[ab]	6.9 ± 0.7[ab]
Eggs	8.3 ± 0.4[b]	8.4 ± 0.5[b]	20.9 ± 1.9[a]	8.9 ± 1.0[b]
Fish and poultry (not fried)	9.8 ± 0.5[b]	12.6 ± 0.7[b]	10.7 ± 1.1[b]	26.2 ± 1.8[a]
Fried fish and poultry	12.9 ± 0.6	10.6 ± 0.5	11.0 ± 1.1	11.2 ± 0.9
Red meat	17.0 ± 0.8[c]	16.0 ± 0.8[c]	45.5 ± 3.6[a]	27.4 ± 2.2[b]
Processed meats and sandwiches	32.4 ± 0.9[b]	31.5 ± 1.0[b]	40.4 ± 2.6[a]	31.7 ± 2.4[b]
Burger sandwiches	13.2 ± 0.5[b]	10.9 ± 0.5[b]	22.4 ± 2.4[a]	8.2 ± 0.8[c]
Other meat sandwiches	11.5 ± 0.5	11.5 ± 0.5	9.2 ± 0.9	9.7 ± 0.7
Peanut butter sandwiches	6.7 ± 0.3[b]	9.2 ± 0.5[a]	5.1 ± 0.6[c]	7.0 ± 0.6[b]
Cheese and spread sandwiches	14.9 ± 0.5[c]	22.4 ± 0.7[a]	16.9 ± 1.2[c]	19.9 ± 1.1[b]
Mixed dishes	73.3 ± 2.2[b]	66.3 ± 2.0[b]	76.9 ± 4.6[b]	88.3 ± 4.3[a]
Pizza	26.9 ± 1.3[a]	20.4 ± 0.9[bc]	23.3 ± 1.8[ab]	16.1 ± 1.5[c]
Ramen	21.9 ± 2.2	15.3 ± 1.5	14.5 ± 3.4	15.7 ± 2.5
Other soups	50.5 ± 2.7[c]	63.9 ± 3.5[bc]	71.5 ± 7.8[b]	94.4 ± 8.2[a]
Fruit	64.9 ± 2.0[c]	84.6 ± 2.3[b]	72.2 ± 4.6[c]	114.6 ± 4.7[a]
Green salad	9.6 ± 0.5[b]	10.3 ± 0.5[b]	12.1 ± 1.1[b]	15.5 ± 1.0[a]
Legumes	7.3 ± 0.6[b]	8.8 ± 0.9[b]	29.7 ± 4.3[a]	7.9 ± 1.4[b]
Other vegetables	25.1 ± 0.9[c]	30.3 ± 1.2[b]	34.0 ± 2.5[b]	54.8 ± 2.7[a]
Potatoes (not fried)	20.3 ± 1.0[b]	21.8 ± 1.1[b]	34.6 ± 3.5[a]	37.0 ± 3.5[a]
Fried potatoes	22.0 ± 0.7[b]	19.3 ± 0.8[bc]	32.4 ± 2.3[a]	17.2 ± 11.5[c]

[1] Values are means ± SEM. Means in a row with superscripts without a common letter differ, $P < 0.05$, adjusted for multiple comparisons (SNK test).

identified for the black girls were characterized by high intakes of fat and sodium, and low intakes of dietary fiber, folic acid, calcium, and potassium.

Despite these important differences between black and white adolescent dietary patterns, it is noteworthy that the first 3 patterns identified among both subgroups did share some commonalities. For both black and white girls, the most common patterns (referred to as Customary and Convenience, respectively) were characterized by a moderate intake of most food groupings, the second most common patterns (Snack-type foods and Sweets and snack-type foods, respectively) were characterized by a high intake of snack-type foods, and a third pattern (Meal-type foods and Fast food, respectively) was characterized by a diet rich in meats. On the basis of our analysis, only a minority of white girls (12%) had diets classified as a Healthy pattern, with foods commonly encouraged for health promotion (such as fruits, green salad, not fried potatoes and other vegetables, plain grains without added fats, not fried poultry and fish, and plain milk and yogurt), and a low intake of foods recommended for consumption in limited quantities (such as soda and other sweetened beverages, chips, fried potatoes, burgers and other red meats, and baked desserts). Although this pattern is classified as "Healthy," it does not imply that these diets meet the dietary guidelines.

The findings for 1 food grouping, legumes, often considered part of a healthy diet, merit additional discussion. Although this food grouping was a common component of the Fast food pattern among white girls, nearly one-half (49%) of legumes consumed by whites were from chili, a menu item readily available at fast food chains and other restaurants. Among black

TABLE 3 Comparison of nutrient intakes from foods by cluster for black girls[1,2]

Nutrient	Customary	Snack-type foods	Meal-type foods	Sweets and cheese
Energy intake[3], *kcal/d*	1909 ± 17.4[b]	1947 ± 25.5[b]	2048 ± 30.5[ab]	2133 ± 77.5[a]
Total fat, *% energy*	36.4 ± 0.1	35.6 ± 0.2	36.6 ± 0.2	36.0 ± 0.6
Cholesterol, *mg*	238.8 ± 3.1[b]	244.8 ± 4.7[b]	292.0 ± 5.7[a]	251.1 ± 15.8[b]
Saturated fat, *% energy*	13.1 ± 0.1[ab]	12.6 ± 0.1[b]	12.8 ± 0.1[b]	13.4 ± 0.3[a]
Monounsaturated fat, *% energy*	13.8 ± 0.1	13.5 ± 0.1	14.0 ± 0.1	13.5 ± 0.3
Total carbohydrate, *% energy*	50.5 ± 0.2	51.3 ± 0.3	49.6 ± 0.3	50.8 ± 0.8
Sucrose, *g/2000 kcal*	52.4 ± 0.5[ab]	53.2 ± 0.8[ab]	49.6 ± 0.7[b]	57.3 ± 3.4[a]
Starch, *g/2000 kcal*	103.6 ± 0.5	102.1 ± 0.8	104.6 ± 0.9	100.1 ± 3.0
Dietary fiber, *g/2000 kcal*	11.4 ± 0.1	11.9 ± 0.1	12.0 ± 0.1	11.2 ± 0.4
Vitamin A, *RE/2000 kcal*	790.7 ± 16.6	738.0 ± 18.2	846.8 ± 26.9	750.1 ± 50.9
Vitamin D, *mg/2000 kcal*	4.8 ± 0.1	4.3 ± 0.1	4.8 ± 0.1	4.4 ± 0.3
Vitamin C, *mg/2000 kcal*	111.5 ± 2.0	122.0 ± 3.5	112.7 ± 2.4	102.3 ± 7.2
Folic acid, *μg/2000 kcal*	250.5 ± 2.7	241.3 ± 4.8	254.2 ± 4.7	243.4 ± 13.8
Vitamin B-6, *mg/2000 kcal*	1.6 ± 0.02	1.8 ± 0.2	1.7 ± 0.02	1.6 ± 0.1
Vitamin B-12, *mg/2000 kcal*	4.5 ± 0.1	4.5 ± 0.3	4.9 ± 0.2	4.6 ± 0.3
Calcium, *mg/2000 kcal*	731.8 ± 6.1[ab]	699.4 ± 8.9[b]	692.4 ± 9.9[b]	774.4 ± 40.6[a]
Iron, *mg/2000 kcal*	13.6 ± 0.3	13.1 ± 0.2	13.6 ± 0.2	13.2 ± 0.5
Magnesium, *mg/2000 kcal*	213.7 ± 1.1	213.4 ± 1.8	218.1 ± 1.8	218.7 ± 7.2
Sodium, *mg/2000 kcal*	3406 ± 16.0	3446 ± 27.8	3506 ± 25.7	3458 ± 71.9
Potassium, *mg/2000 kcal*	2011 ± 10.4	2044 ± 18.4	2102 ± 16.8	2016 ± 45.2
Zinc, *mg/2000 kcal*	10.2 ± 0.1	10.2 ± 0.1	10.9 ± 0.1	11.0 ± 0.5

[1] Values are means ± SEM. Means in a row with superscripts without a common letter differ, $P < 0.05$, adjusted for multiple comparisons (SNK test).
[2] Does not include nutrient intake from vitamin/mineral supplements.
[3] 1 kcal = 4.184 kJ.

girls, a smaller percentage of legumes (37%) were from chili, and accordingly, this food grouping was consumed in relatively high amount by black girls following the Meal-type food and Sweet and cheese patterns.

Given that most of the dietary patterns identified were far from optimal, it is not surprising that few were found to be protective against obesity. A notable exception was the Healthy pattern identified among white girls. Both the final waist

TABLE 4 Comparison of nutrient intakes from foods by cluster for white girls[1,2]

Nutrient	Convenience	Sweets and snack-type foods	Fast food	Healthy
Energy intake[3], *kcal*	1734 ± 15.1[b]	1818 ± 16.1[a]	1878 ± 38.0[a]	1844 ± 27.1[a]
Total fat, *% energy*	34.0 ± 0.2[b]	32.1 ± 0.2[c]	35.6 ± 0.3[a]	31.5 ± 0.4[c]
Cholesterol, *mg*	189.3 ± 2.6[bc]	184.9 ± 2.8[c]	244.2 ± 7.3[a]	201.3 ± 5.7[b]
Saturated fat, *% energy*	12.8 ± 0.1[b]	12.0 ± 0.1[c]	13.4 ± 0.1[a]	11.8 ± 0.2[c]
Monounsaturated fat, *% energy*	12.6 ± 0.1[b]	11.9 ± 0.1[c]	13.4 ± 0.1[a]	11.5 ± 0.2[d]
Total carbohydrate, *% energy*	52.7 ± 0.2[b]	54.9 ± 0.2[a]	54.6 ± 0.4[a]	50.3 ± 0.4[c]
Sucrose, *g/2000 kcal*	50.8 ± 0.6[ab]	52.6 ± 0.6[a]	46.9 ± 1.2[c]	49.4 ± 1.0[cb]
Starch, *g/2000 kcal*	108.4 ± 0.6[b]	110.6 ± 0.7[b]	102.6 ± 1.2[c]	115.2 ± 1.4[a]
Dietary fiber, *g/2000 kcal*	12.5 ± 0.1[c]	13.5 ± 0.1[b]	12.2 ± 0.2[c]	15.9 ± 0.3[a]
Vitamin A, *RE/2000 kcal*	928.6 ± 14.6[c]	1034.1 ± 24.8[b]	903.5 ± 29.9[c]	1269.5 ± 57.5[a]
Vitamin D, *mg/2000 kcal*	6.3 ± 0.1	6.5 ± 0.1	6.3 ± 0.2	7.3 ± 0.3
Vitamin C, *mg/2000 kcal*	107.7 ± 4.4[c]	134.8 ± 4.0[b]	109.8 ± 5.3[c]	154.1 ± 8.8[a]
Folic acid, *μg/2000 kcal*	270.8 ± 3.6[c]	300.5 ± 5.2[b]	266.0 ± 7.2[c]	333.2 ± 9.2[a]
Vitamin B-6, *mg/2000 kcal*	1.8 ± 0.1[b]	1.8 ± 0.0[b]	1.6 ± 0.03[b]	2.6 ± 0.4[a]
Vitamin B-12, *mg/2000 kcal*	5.0 ± 0.2	4.6 ± 0.1	5.4 ± 0.3[a]	5.3 ± 0.3
Calcium, *mg/2000 kcal*	962.8 ± 9.6[b]	960.6 ± 11.7[b]	922.5 ± 17.4[b]	1021.9 ± 21.0[a]
Iron, *mg/2000 kcal*	14.2 ± 0.2[c]	15.2 ± 0.4[b]	13.8 ± 0.3[c]	16.5 ± 0.5[a]
Magnesium, *mg/2000 kcal*	239.8 ± 1.8[c]	248.7 ± 2.0[b]	234.1 ± 3.0[c]	276.0 ± 3.7[a]
Sodium, *mg/2000 kcal*	3284 ± 19.9[cb]	3204 ± 20.5[c]	3389 ± 40.5[a]	3325 ± 42.1[ab]
Potassium, *mg/2000 kcal*	2237 ± 16.1[c]	2315 ± 19.1[b]	2332 ± 30.3[b]	2626 ± 34.0[a]
Zinc, *mg/2000 kcal*	10.5 ± 0.1[b]	10.4 ± 0.1[b]	11.0 ± 0.2[a]	11.5 ± 0.3[a]

[1] Values are means ± SEM. Means in a row with superscripts without a common letter differ, $P < 0.05$, adjusted for multiple comparisons (SNK test).
[2] Does not include nutrient intake from vitamin/mineral supplements.
[3] 1 kcal = 4.184 kJ.

TABLE 5 Comparison of adjusted adiposity measures by dietary pattern and subgroup[1]

Dietary pattern	n	BMI		Body fat		Waist circumference	
		Final	Change[2]	Final	Change[2]	Final	Change[2]
Black		*kg/m²*		*%*		*cm*	
Customary	643	27.2 ± 0.20	8.02 ± 0.20	33.8 ± 0.40	12.3 ± 0.40	79.7 ± 0.37	12.9 ± 0.37
Snack-type foods	276	26.8 ± 0.30	7.56 ± 0.30	32.7 ± 0.60	11.2 ± 0.60	78.9 ± 0.56	12.2 ± 0.56
Meal-type foods	269	26.8 ± 0.31	7.59 ± 0.31	33.1 ± 0.62	11.6 ± 0.62	78.5 ± 0.57	11.7 ± 0.57
Sweets and cheese	23	28.3 ± 1.03	9.04 ± 1.03	36.3 ± 2.07	14.8 ± 2.07	78.7 ± 1.92	12.0 ± 1.92
White							
Convenience	521	24.1 ± 0.18	6.14 ± 0.18	28.8 ± 0.37	8.21 ± 0.37	74.5 ± 0.37[ab]	11.1 ± 0.37[ab]
Sweets and snack-type foods	380	24.0 ± 0.20	6.09 ± 0.20	28.8 ± 0.41	8.28 ± 0.41	75.1 ± 0.40[a]	11.7 ± 0.40[a]
Fast food	118	24.2 ± 0.32	6.24 ± 0.32	29.7 ± 0.67	9.16 ± 0.67	74.7 ± 0.66[ab]	11.2 ± 0.66[ab]
Healthy	141	23.5 ± 0.41	5.55 ± 0.41	27.7 ± 0.86	7.11 ± 0.86	73.2 ± 0.85[b]	9.7 ± 0.85[b]

[1] Values are means ± SEM. Means in a column with superscripts without a common letter differ, $P < 0.05$, not adjusted for multiple comparisons but adjusted for corresponding adiposity measure at baseline, age of menarche, pregnancy, parental education, physical activity, and TV/video watching (ANOVA).
[2] Change in adiposity measure between study year 10 (final, age 18–19 y) and study year 1 (baseline, age 9–10 y).

circumference and the change in waist circumference from ages 9–10 y to 18–19 y were significantly lower for white girls following this pattern in comparison to the Sweets and snack-type foods pattern. Given that a large waist circumference has emerged as an important risk factor for chronic disease, even more so than BMI (11,12), this finding is consistent with recommendations for health promotion to eat a diet rich in fruits, vegetables, and whole grains and low in fat- and sugar-laden, energy-dense, nutrient-poor foods.

No studies have heretofore found an association between adiposity (as assessed by waist circumference) and a healthy diet pattern in youth. Others have observed this association in adults. In a 12-y longitudinal assessment of the relation between dietary patterns and overweight in a predominantly white sample of middle-aged women, the crude risk of becoming overweight was 24% for women in the "heart healthy" dietary pattern compared with 41% for those following an "empty calorie" pattern rich in sweetened beverages, high-fat sweets, and empty-calorie snack foods and low in fruits, vegetables, and fiber-rich foods (13). Further, a longitudinal study with a 2-y mean follow-up also found that a healthy dietary pattern (characterized by a diet high in fruit, vegetables, reduced-fat dairy, and whole grains and low in red and processed meat, fast food, and soda) was associated with smaller gains in BMI and waist circumference among a sample of white middle-aged adults (14). A similar finding was observed in a cohort of German men and women, where a 2-y longitudinal study found that intake of high-energy, high-fat food groups (e.g. fats, meats, and sauces) among women and intake of high-energy, high-sugar foods (e.g. soft drinks and sweets) among men was predictive of large weight gain (15).

During the period of transition from childhood to adulthood, we expect to see a corresponding fluctuation in dietary patterns. In support of this hypothesis, we found that comparable dietary patterns by adolescent stage were not identifiable (data not shown), further supporting our decision to aggregate the dietary data across all study years. Interestingly, Greenwood and colleagues (16) found only 55% of adult women maintained the same dietary pattern at baseline and 5 y later. Adolescent dietary patterns are anticipated to be more transient, reflecting the degree of fluctuation that normally occurs over this period of the lifecycle compared with adulthood as well as due to the longer (10 y) period of study.

It is worth noting that the mean intake of many of the food groupings changed as the girls grew older, notably for example, soda intake increased and milk intake decreased (17). However, because it is the cumulative pattern of intake over many years that contributes to measurable changes in adiposity, we chose to take advantage of the longitudinal nature of the data collected by combining intake from all years of the study to derive more representative dietary patterns. Because dietary intakes were measured using 3-d diet records at up to 8 time points, up to 24 d of diet assessment per individual were used to assess the cumulative influence of diet on adiposity outcomes.

Several limitations of our analysis must be acknowledged. Only black and white girls were included in the NGHS, as the focus of the study was on identification of heart disease factors in African American girls. Performing separate cluster analyses for black and white girls was done to best describe patterns typical of each subgroup. Initially, cluster analyses were performed using dietary information from both subgroups combined. However, the identified groups were difficult to interpret, causing us to suspect that the black-white differences in food intake that existed were masked by combining the data.

The large number of subjects with no intake of certain food groupings and the small number of subjects in several of the identified clusters may have limited our ability to detect differences in food intake by cluster. It must also be acknowledged that national trends in food intake suggest that since the 1990s when the NGHS study was conducted, considerable changes in dietary patterns have occurred. Notably, intakes of sweetened beverages and convenience foods have increased (1). However, given the large gains in childhood overweight during the period of the study and given the fact that the dietary trends common during this period have not seen improvements, it is likely that these findings would not be unlike findings from young women after 1997. Finally, because of the observational nature of our study and the possibility of residual confounding that we were not able to account for, our results must be interpreted with caution. Although conducting a randomized, controlled trial would be the most rigorous way to test hypotheses on the role of dietary patterns in preventing overweight in youth, it is not a practical approach.

In summary, to our knowledge, this is the first study to apply dietary patterns methodology to systematically evaluate the diets of adolescents. Further, no longitudinal studies addressing dietary patterns in relation to the development of obesity have been conducted among blacks in youth or adulthood. Most previous studies that have assessed the association between dietary patterns and obesity have been cross-sectional in design, have relied upon assessment of diet and adiposity at a single point in time, and have focused on older white adults. In our sample of black adolescents, none of the dietary patterns that emerged might be considered nutritionally optimal and none protect against increasing adiposity. Among white adolescents, a small group followed a Healthy pattern, which was not only optimal in terms of nutrient intake but was shown to be protective against large increases in waist circumference. Among both black and white girls, dietary patterns characterized by high intakes of energy-dense, nutrient poor snack-type foods tended to be associated with higher adiposity. Our findings point to the need for a better understanding of the factors contributing to the different dietary patterns of black and white young women and the protective effect of a Healthy diet for the small group of youth who practiced this pattern of intake.

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Literature Cited

1. Woodward-Lopez G, Ritchie LD, Crawford PB, Gerstein D. Obesity: dietary and developmental influences. Boca Raton: CRC Press; 2006.
2. Millen BE, Quatromoni PA, Gagnon DR, Cupples LA, Franz MM, D'Agostino RB. Dietary patterns of men and women suggest targets for health promotion: The Framingham Nutrition Studies. Am J Health Promot. 1996;11:42–53.
3. Hu FB, Rimm E, Smith-Warner SA, Feskanich D, Stampfer MJ, Ascherio A, Sampson L, Willett WC. Reproducibility and validity of dietary patterns assessed with a food-frequency questionnaire. Am J Clin Nutr. 1999;69:243–9.
4. Millen BE, Quatromoni PA, Copenhafer DL, Demissie S, O'Horo CE, D'Agostino RB. Validation of a dietary pattern approach for evaluating nutritional risk: The Framingham Nutrition Studies. J Am Diet Assoc. 2001;101:187–94.
5. Tseng M, DeVelles RF. Fundamental dietary patterns and their correlates among US whites. J Am Diet Assoc. 2001;101:929–32.
6. Gittelsohn J, Wolever TM, Harris SB, Harris-Giraldo R, Hanley AJ, Zinman B. Specific patterns of food consumption and preparation are associated with diabetes and obesity in a Native Canadian community. J Nutr. 1998;128:541–7.
7. The National Heart, Lung, and Blood Institute Growth and Health Study Research Group. Obesity and cardiovascular disease risk factors in black and white girls: the NHLBI Growth and Health Study. Am J Public Health. 1992;82:1613–9.
8. Crawford PB, Obarzanek E, Morrison J, Sabry ZI. Comparative advantage of 3-d food records over 24-h recall and 5-d food frequency validated by observation of 9- and 10-year-old girls. J Am Diet Assoc. 1994;94:626–30.
9. Stevens M, Kiesling S, Scholff P, Himes J. Preparing National Growth and Health Study (NGHS) dietary intake data to analyze eating patterns. The 27th US National Nutrient Databank Conference; 2003 June 30–July 2; Washington, DC (abstract). Available from: http://www.nal.usda.gov/fnic/foodcomp/conf/NDBC27_IFDC5/pgm_post.html.
10. Crawford PB, Obarzanek E, Schreiber GB, Barrier P, Goldman S, Frederick MM, Sabry ZI. The effects of race, household income and parental education on nutrient intakes: NHLBI Growth and Health Study. Ann Epidemiol. 1995;5:360–8.
11. Savva SC, Tornaritis M, Savva ME, Kourides Y, Panagi A, Silikiotou N, Georgiou C, Kafatos A. Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. Int J Obes Relat Metab Disord. 2000;24:1453–8.
12. Janssen I, Katzmarzyk PT, Ross R. Body mass index, waist circumference, and health risk: evidence in support of current National Institutes of Health guidelines. Arch Intern Med. 2002;162:2074–9.
13. Quatromoni PA, Copenhafer DL, D'Agostino RB, Millen BE. Dietary patterns predict the development of overweight in women: The Framingham Nutrition Studies. J Am Diet Assoc. 2002;102:1240–6.
14. Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. Am J Clin Nutr. 2003;77:1417–25.
15. Schulz M, Kroke A, Liese AD, Hoffmann K, Bergmann MM, Boeing H. Food groups as predictors for short-term weight changes in men and women of the EPIC-Potsdam cohort. J Nutr. 2002;132:1335–40.
16. Greenwood DC, Gilthorpe MS, Golding C, Cade JE. Stability over time of dietary patterns in the UK Women's Cohort Study. In: Proceedings of the Nutrition Society. Cambridge: Cambridge University Press; 2003. p. 89.
17. Ritchie L, Spector P, Stevens M, Hudes M, Mandel S, Crawford P. Food patterns among adolescent white girls: The NHLBI Growth and Health Study. The 27th US National Nutrient Databank Conference; 2003 June 30–July 2; Washington. (abstract). Available from: http://www.nal.usda.gov/fnic/foodcomp/conf/NDBC27_IFDC5/pgm_post.html.