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Dietary patterns change over two years in early adolescent girls in Hawai'i

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Abstract

Background and Objectives—In investigating diet-disease relationships, examination of dietary patterns allows for conclusions to be drawn based on overall intake. This study characterized dietary patterns of early adolescent girls over a two-year period and examined the relationship between dietary patterns and body mass index (BMI).

Methods and Study Design—Cross-sectional analyses were performed using longitudinal data from food records of early adolescent girls (n=148) 9 to 14 years in Hawaiʻi from the Female Adolescent Maturation (FAM) study. Dietary patterns were identified using principal component analysis (PCA). Pearson's correlations between BMI percentile and z-score and dietary pattern factor scores at Times 1 (2001–2002) and 2 (2002–2003) were calculated. For each dietary pattern, participants were divided into low, intermediate, and high scorers. Mean BMI percentiles and z-scores were compared between groups using analysis of covariance.

Results—At Time 1, three patterns were identified, characterized by: (1) whole grains, nuts and seeds, added sugar; (2) non-whole grain, tomatoes, discretionary fat; and (3) deep yellow vegetables, other starchy vegetables, cooked dry beans/peas. At Time 2, three different dietary patterns emerged: (1) non-whole grains, meat, discretionary fat; (2) other vegetables, fish, eggs; and (3) whole grain, tomatoes, other vegetables. BMI percentile and z-score differed between high and low scorers on Time 1-Pattern 1 and Time 2-Pattern 3.

Conclusion—Results revealed changes in dietary patterns over time and an association between intake and BMI. Findings demonstrate the importance of frequent nutrition assessment to monitor changes in intake that may be improved to prevent obesity.

Keywords

dietary patterns; principal component analysis; body mass index; obesity; adolescents

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INTRODUCTION

National reports estimate that about 21% of U.S. adolescents are obese.[1] Although removed from the contiguous U.S., the state of Hawai‘i is not immune to the nation's rise in obesity prevalence. While there are few population-based data available on overweight and obesity in children in the Pacific region, studies indicate that obesity remains a major threat among youth.[2] In the years 2011–2012, 27% of adolescents ages 10–17 in Hawai‘i were classified as overweight or obese.[3] Dietary intake during childhood and adolescence is related to the development of obesity in youth, and also has important short- and long-term health effects.[4,5]

Despite a large body of research examining the effects of dietary intake on the development of obesity in youth, this relationship is complex and has yet to be fully elucidated.[6] Previous studies focused on exploring the association between dietary intake and health outcomes have traditionally examined specific components of the diet, such as nutrients, foods, or food groups.[7–9] In investigating diet-disease relationships, an all-inclusive examination of dietary patterns rather than intake of individual foods or food groups may be beneficial, as conclusions may be drawn based on overall intake of a diverse diet.[10]

Cross-sectional studies investigating the relationship between dietary patterns and obesity in adolescents have yielded mixed results. Some studies have shown that certain dietary patterns were associated with overweight, obesity, and obesity-related conditions.[11,12] A study of 3760 Japanese female students ages 18–20 years, for example, revealed that the ‘Healthy’ pattern identified (characterized by high intakes of vegetables, fruit, fish and soy) was associated with a lower risk of overweight, while the ‘Japanese traditional’ pattern (with high intakes of rice and soy) and the ‘Western’ pattern (with high intakes of meat, fats, and seasonings) were both associated with an increased risk of overweight.[11] Another study of 764 Australian adolescents found that the dietary pattern characterized by fruit, salad, cereals and fish was inversely associated with diastolic blood pressure.[12] Other studies revealed no association between dietary patterns and weight-related factors.[13–15] Studies involving cross-sectional analyses using longitudinal data have also produced mixed findings. A study of multiethnic adolescents in Minnesota, for example, showed that dietary patterns were not associated with weight-related factors.[16] Other studies have shown that certain dietary patterns were associated with overweight, obesity, and/or obesity-related conditions.[17–20] For instance, a study of 1045 early adolescents in Norway revealed that adolescents adhering to a ‘varied Norwegian’ (characterized by fish and meat, cheese, brown bread and fruit and vegetables) or a ‘dieting’ (characterized by artificially sweetened soft drinks and low-fat dairy products) eating pattern had a significantly higher likelihood of being overweight.[17] Another study of 4,347 Korean adolescents found that the ‘Western’ dietary pattern (characterized by high intake of bread, pizza and hamburgers, meat, dairy and soft drinks) increased the risk of overweight and having elevated serum triglycerides.[20]

While previous studies have examined intake of individual nutrients and food groups in adolescents in Hawai‘i,[21,22] dietary patterns of this group have not yet been explored. As the physical, developmental and social changes that take place in adolescence can have a profound effect on eating behaviors and health, characterizing the diet of this population is of importance.[23] The changes that occur during this period and resulting shift in dietary habits may increase risk of development of chronic disease, with lasting effects later in life.[24] Adolescent girls are at particular nutritional risk, as previous studies have indicated that many girls are not meeting dietary recommendations and have lower intake of essential nutrients such as calcium than boys as dietary habits change in adolescence.[25] Furthermore, previous studies have shown that multiple dietary patterns can be identified in adolescents at a given time point and may change over time within the same population,[11–20] which has particular implications for Hawai‘i due to the lack of organized statewide nutrition assessment. Comprehensive information on diet collected on an annual basis in the state is lacking, as Hawai’i does not participate in the National Health and Nutrition Examination Survey (NHANES).[26] Given the lack of Hawai‘i-specific information regarding dietary patterns in adolescents, the current study aimed to: (1) characterize dietary patterns in early adolescent girls age nine to 14 years on O‘ahu at two time points over a two-year period; and (2) examine the relationship between dietary patterns and body mass index (BMI) percentile and z-score.

PARTICIPANTS AND METHODS

Study design

A secondary data analysis from the Female Adolescent Maturation (FAM) study, which was designed to investigate dietary, physical activity, hormonal, and genetic factors that may influence adolescent growth, development, and maturation in the early and mid-2000s, was performed.[21]

Study population

Recruitment and characteristics of participants in the FAM study have been described previously.[21] Briefly, at the time of data collection, age-eligible early adolescent girls were selected from the membership files of Kaiser Permanente, a managed care system in Hawai‘i. The participant selection criteria were: (1) healthy early adolescent girl living on O‘ahu; (2) between the ages of nine and 14 years; and (3) no history of chronic diseases or use of asthma, antiepileptic, or steroid medications. Because the current secondary analysis involves the use of longitudinal data, an additional criterion for inclusion in the analysis was participation in and having complete data for the first two FAM study years: 2001–2002 (Time 1) and 2002–2003 (Time 2). A total of 148 early adolescent girls met these criteria. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Institutional Review Boards at the University of Hawai‘i at Mānoa and the managed care system. Written informed consent was obtained from all adolescents and their parents.

Demographics

Race and age information was obtained from parents at Time 1 using the BLEND questionnaire, which captures ethnic mixing through taking the sum of the mother’s and father’s race/ethnicity.[27] Girls’ race was determined based on the parents’ reported race.

Girls were classified as Mixed Race if the parents reported being of two or more different race groups.

Anthropometric measurements

Anthropometric measurements, which included weight and height, among other measures, were taken during a visit to the managed care facility at Time 1 and Time 2. Weight was measured with a scale (Seca, Chino, California) and height was measured using a digital stadiometer (Measurement Concepts, North Bend, Washington), with the closest two of three measurements averaged and used in the analysis.[21] BMI percentile and z-score were calculated based on the Centers for Disease Control and Prevention (CDC) BMI-for-age growth charts.[28]

Dietary intake

Dietary data were collected at Time 1 and Time 2 using a 3-day food record that was completed by the participants with their parents' assistance on a Thursday, Friday and Saturday sequence before their study measurement visit. The food record was mailed 2 weeks before their visit, with instructions that included which day to record; what to record; and a measuring cup, spoon, and paper ruler to estimate quantities of each food item eaten. The project staff reviewed the diet record with participants to clarify any food description and amounts eaten. Children recorded data with assistance of a parent. Nutrient and food group analyses were performed at the University of Hawai‘i Cancer Center using the Shared Nutrition Food Composition Database, which is customized to the multiethnic population of Hawai‘i; data were entered by one Registered Dietitian Nutritionist and checked by a second to verify correctness.[21] Foods reported in the food records were categorized into the 30 United States Department of Agriculture (USDA) food groups used at the time of data collection. Because the 2000 United States Dietary Guidelines for Americans were used at the time of the initial study, we used the 2000 Food Guide Pyramid to categorize foods into groups.[29]

Statistical analyses

Analyses were performed using SAS 9.4 (SAS Institute, Cary NC). Energy intake, BMI percentile, and BMI z-score were compared at both time points using a paired t-test. Prior to performing the factor analysis, the average food serving intake of the three day food records for 25 of the 30 USDA standardized food groups (total grain, total vegetable, total fruit, total dairy, and alcohol intake were excluded) were converted to absolute weight in grams per day using the following formula: i) 1 serving size=118 g for grains, vegetables, and fruits; 1 serving size=237 g for dark green leafy vegetable, milk, and yogurt; iii) 1 serving size=42 g for cheese; iv) 1 ounce=28 g for protein food source (i.e., meat, organ meats, frankfurters, sausage, poultry, fish, eggs, cooked dry beans and peas, soybean products, and nuts and seeds); and 1 tablespoon=4 g for added sugars.[30] Then, box-cox transformations were used for the food groups that did not meet normality assumption. Principal component analysis (PCA) used the transformed variables to identify dietary patterns at each time and factors were retained according to scree plots and eigenvalues >1. The organ meat food group was excluded from PCA because only one participant consumed it at Time 1. Factor scores were calculated using regression.[31] The relationship between dietary patterns and weight status was investigated by Pearson's correlation between BMI percentile and z-score and factor scores of each dietary pattern at Time 1 and Time 2. Finally, for each dietary pattern, participants were divided into tertiles, defined as low, intermediate, and high scorers, based on their factor scores. Mean BMI percentiles and z-scores among the scorers on each pattern were then compared between the tertiles using analysis of covariance (ANCOVA), adjusting for race. Interaction between the tertiles and race was also examined. Tukey's post-hoc test was implemented with adjustment for multiple comparisons. Sensitivity analyses were conducted using the participants who were not obese (obese was defined as BMI percentile >95%: 18 and 11 obese females at Time 1 and Time 2, respectively). A *p*-value <0.05 was considered statistically significant.

RESULTS

Participant characteristics

Participant characteristics are summarized in Table 1. The majority of participants were Mixed Race (56.8%), followed by Asian (26.3%) and White (16.9%), respectively. Out of the 84 Mixed Race participants, 36 (43%) were part Hawaiian or Pacific Islander. Mean age at Time 1 was 11.1±1.4 years.

Dietary pattern identification & description

At Time 1, three dietary patterns were identified by PCA. The foods with factor loadings >0.20 for the three patterns are presented in Table 2. For each pattern, the three items with the highest factor loadings were considered to characterize the pattern. The first dietary pattern, termed T1-P1, was characterized by whole grains, nuts and seeds, and added sugar. The second dietary pattern, termed T1-P2, reflected high intakes of non-whole grain, tomatoes, and discretionary fat. The third dietary pattern, termed T1-P3 was characterized by high intakes of deep yellow vegetables, other starchy vegetables, and cooked dry beans/ peas. The results of the PCA at Time 2 revealed three distinct dietary patterns (Table 2). These patterns were: (1) T2-P1, characterized by high intakes of non-whole grains, meat, and discretionary fat; (2) T2-P2, characterized by high intakes of other vegetables, fish, and eggs; and (3) T2-P3, characterized by high intakes of whole grain, tomatoes, and other vegetables. Although some of the foods (namely deep yellow vegetables, other vegetables, and cooked dry beans and peas) in the T1-P3 also characterized the T2-P3 pattern, the dietary patterns at Time 1 were distinct from those at Time 2.

Relationship between dietary patterns and weight status

Table 3 represents the correlation between each dietary pattern and energy intake, BMI z-score and percentile. A significant positive correlation between the factor score for each dietary pattern and energy intake was found for all dietary patterns except T2-P3. BMI percentile and z-scores were negatively correlated with T1-P1 and T2-P3. Table 3 also represents unadjusted means and standard deviations and adjusted means and 95% confidence intervals of energy intake, BMI percentile and BMI z score between the tertiles. Since the Mixed Race females had significantly higher BMI percentiles and z scores than Asians, race was included as a confounding factor in each ANCOVA. We also examined interaction between the tertiles and race but found to be insignificant (not shown). When comparing mean BMI percentiles and z-scores among the tertiles of each dietary pattern at Time 1, significant differences existed between low and high scores in the T1-P1 (Table 3). Low scorers for T1-P1 had higher BMI percentiles and z-scores compared to high scorers. At Time 2, mean BMI percentiles and z-scores of low or intermediate scores were significantly higher compared to high scores of T2-P3. As a sensitivity analysis, the same models were applied to the participants who were not obese. The results were very similar in direction and difference between the tertiles although the magnitude of parameter estimates for energy intake and BMI percentiles and z scores were smaller (results not shown).

In addition, to investigate how dietary patterns changed over time, correlations were computed between factor scores at Time 1 and Time 2. We found significant correlations between T1-P1 and T2-P3 ($r=0.256$, $p=0.002$), between T1-P3 and T2-P2 ($r=-0.162$, $p=0.049$), and between T1-P3 and T2-P3 ($r=-0.191$, $p=0.020$). That is, participants who had higher scores on T1-P1 were more likely to have high scores on T2-P3, but participants who had higher scores on T1-P3 were less likely to have high scores on T2-P2 and T2-P3.

DISCUSSION

The current study aimed to investigate dietary patterns and the relationship between dietary pattern intake score and BMI percentile and z-score at two time points in multicultural early adolescent girls in Hawai‘i. This study is the first to examine dietary patterns of early adolescents living in Hawai‘i using PCA, and holds important implications due to the lack of regular nutrition assessment in the state.

With regards to dietary patterns identified in the population under study, some appear to generally represent a “healthier” diet, while others seem to be less reflective dietary recommendations. Oellingrath et al note that most dietary pattern studies include one pattern characterized by a mixture of processed and convenience/junk foods, one pattern featuring high loadings with regard to vegetables and other food items associated with a health-conscious lifestyle and one pattern featuring traditional natural foods.[17] In the current study, T1-P2 (high intakes of non-whole grain, tomatoes, and discretionary fat) and T2-P1 (characterized by high intakes of non-whole grains meat, and discretionary fat) may reflect intake of processed and convenience foods. Other patterns identified, such as T1-P3 (characterized by high intakes of deep yellow vegetables, other starchy vegetables, and cooked dry beans/peas) and T2-P2 (characterized by high intakes of other vegetables, fish, and eggs) may reflect consumption of food items meeting dietary recommendations, including traditional foods.

Different dietary patterns were identified at Time 1 and Time 2, reflecting changes in habits over the two-year period. At Time 2, milk, fruit, potatoes, nuts and seeds, and frankfurters did not load onto any of the patterns as they did at Time 1, while dark green leafy vegetables newly loaded onto the patterns. Along with dark green leafy vegetables, items such as deep yellow vegetables, other vegetables, and poultry also characterized patterns at Time 2, implying transitioning to a more nutrient dense diet at time 2. Factors influencing this tendency would be interesting to explore further. While one of the patterns identified at Time 1 (T1-P1) was characterized by foods falling into each of the groups in the 2000 Food Guide

Pyramid when all items loaded on the pattern were examined, [29] none of the patterns identified at Time 2 reflected these guidelines. Instead, one of the patterns identified at Time 2 (T2-P1) was characterized by non-whole grains, animal products, and added sugar, while another (T2-P2) was characterized by starchy foods, vegetables, and animal products. Changes in intake may reflect the shift in dietary habits that has been previously reported during adolescence. An examination of the top dietary sources of energy, solid fats, and solid sugars in two to 18-year-old participants in NHANES revealed that dairy is a lesser contributor to overall energy intake in adolescence versus childhood.[32] This same study also showed that pizza became a larger contributor to overall energy intake in adolescents than in younger children, which may be reflected in changes in patterns. During this phase of life, adolescents gain greater independence in decision-making and responsibility for health-related behaviors.[33,34] Adolescents' diets can also be influenced by the family context;[33] however, the home environment influences tend to diminish in adolescence and compete with external influences, such as the influence of peers and friends.[35] The current study also was performed during a period in which participants made a transition from elementary school to middle school and may have been introduced to new foods by their peers and friends or had greater access to new foods at school.

When the relationship between the dietary patterns and BMI was examined, significant differences in BMI percentile and z-score between low and high scorers on several of the dietary patterns at both time points were observed. For example, regarding T1-P1, characterized by foods falling into each of the groups in the 2000 Food Guide Pyramid, the BMI percentile of low scorers was significantly higher than that of intermediate and high scorers. A number of other studies have also observed intuitive associations between dietary patterns and overweight, obesity, and/or obesity-related conditions.[17–20] Not all studies, however, have revealed such associations. One such study is Project Eating Among Teens (EAT), a longitudinal study of the socio-environmental, personal, and behavioral determinants of dietary intake and BMI among an ethnically diverse adolescent population in Minnesota.[36] Analysis of the dietary patterns of the Project EAT revealed no consistent associations between dietary patterns and BMI. The researchers concluded that the dietary patterns may not capture the elements of the diet that are determining adolescent weight, or they may not be the primary driver of weight status at this age.[16] Differences in findings related to stability of dietary patterns over time and relationship to weight status may be due to a number of factors, one of which is the use of different dietary data collection tools, which may affect the form and utility of dietary patterns.[37] For example, with a one 24-hour recall, random error from day-to-day variability in intake can contribute to misclassification of usual dietary patterns; therefore, multiple days of dietary intake are needed, as they better reflect usual nutrient intake.[37] Food frequency questionnaires may limit food groupings and can obscure ethnic or other food-choice differences if specific foods are collapsed into a larger group.[37] Studies investigating dietary patterns in adolescents demonstrate considerable variability in the methods and findings; however, to comprehensively examine the relationship between dietary habits and health, particularly in this population, the dietary pattern approach may yield more intuitive insight than examination of individual nutrients, foods or food groups.[37]

Of note, a previous study described dietary change in comparison with dietary guidelines over the two-year period from 2001 to 2003 (Time 1 to Time 2) in 151 of the FAM study participants.[22] This study found the following: (1) at both Time 1 and Time 2, more than half of early adolescents did not consume the recommended number of servings for any of the food groups, and intake of saturated fat in most early adolescents was higher than the recommendation; and (2) from Time 1 to Time 2, there was a significant increase in sweetened carbonated beverage and added sugar intake.[22] This suggests that there may be high intakes of dietary fat and increasing intakes of added sugar and sweetened carbonated beverages during adolescence among girls in Hawai‘i.[22] Although the current study did not include beverages other than milk in the analysis, high intake of added sugar (which included added sugar from beverages) was characteristic of only the T1-P1 and T2-P1 dietary patterns. Milk, which loaded on to T1-P1, did not load similarly at Time 2. In line with the findings from Lee et al,[22] this suggests that dairy may have been displaced by sweetened carbonated beverages at Time 2 in some individuals, a change in adolescent dietary habits that has been well documented.[38] Although dietary pattern analysis does not detect increases or decreases in intake of specific foods, it does characterize the pattern of eating in which such eating habits occur. In Hawai‘i, specifically, further work should be done to provide an up-to-date report of dietary patterns and habits in adolescents and any other factors relating to dietary change.

The findings of the current study have numerous implications for the health and nutrition fields. For the state of Hawai‘i specifically, it is critical to conduct structured, frequent nutrition assessment, particularly in adolescents, given that this period is marked by growth and development, as well as change in dietary habits. Routinely collected information on diet in the state is lacking, as Hawai’i does not participate in NHANES.[26] It is also important to further assess the association between dietary intake and short- or long-term effects on health in this population. For researchers, it is important to determine the likely reasons for dietary pattern intake change, which would provide further context related to particular dietary patterns and eating habits and inform nutrition-related interventions. Use of a mixed methods approach to nutrition studies is a means by which to further explore the relationship between the observed patterns and health in greater depth.[39] Researchers can add value to the findings and to the field by combining both quantitative and qualitative methods to explore the reasons for dietary pattern change and the potential effect on health.[39]

Strengths and limitations

Strengths of the current study include identification and characterization of dietary patterns in early adolescents in Hawai‘i, a topic that has not been previously explored. Findings reflecting changes in dietary patterns over a two-year period highlight the need for a regular nutrition assessment system to monitor and investigate potential impacts of diet on health in this population.

The current study also has several limitations. The original recruitment scheme, which involved those who have insurance, may have excluded certain race and socioeconomic groups. In addition, the relatively small sample size did not allow for extensive comparison among smaller subgroups, and the findings may not reflect current dietary patterns of early adolescent girls on Oʻahu, as the FAM data were collected a decade ago. Also, information regarding nutrient intake was unavailable for the analysis, as well as other information on dietary habits such as consumption of breakfast, fast food and snacking. Finally, the current study did not include beverages other than milk in the analysis.

Conclusions

Few studies on dietary patterns in adolescents have investigated the change in dietary pattern intake over time, and the current study is the first to describe dietary patterns using PCA among early adolescents over time in Hawaiʻi. The results of the current study provide insight to the potential change in dietary habits that may occur in early adolescent girls in Hawaiʻi and highlight the need for frequent nutrition monitoring in this population.

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Table 1

Characteristics of adolescent females nine to 14 years on Oʻahu, Hawaiʻi participating in the Female Adolescent Maturation Study (n=148)

Characteristic	Time 1	Time 2	*p*-value†
Age (yr), mean±SD	11.1±1.4	13.1±1.4	<0.01
Energy intake (kcal/day), mean±SD	1800±443	1836±489	0.46
BMI percentile, mean±SD	59.7±29.4	58.2±27.73	0.20
BMI z-score, mean±SD	0.4±1.1	0.3±0.9	0.06
Age (yr), n (%)			
9–10	59 (39.9)		
11–12	57 (46.0)	58 (39.2)	
13–14	32 (21.1)	56 (37.8)	
15–16		34 (22.0)	
Weight status, n (%)			
Under- or healthy weight	105 (70.9)	115 (77.7)	
Overweight	25 (16.9)	22 (14.9)	
Obese	18 (12.2)	11 (7.4)	
Race, n (%)			
Mixed	84 (56.8)	N/A	
Asian	39 (26.3)	N/A	
White	25 (16.9)	N/A	

SD: standard deviation; BMI: body mass index.

†To compare Time 1 and Time 2, paired t test was used for continuous variables.

Table 2

Factor loadings for the dietary patterns identified at Time 1 and Time 2 of adolescent females nine to 14 years on O‘ahu, Hawai‘i participating in the Female Adolescent Maturation Study (n=148)

Food group (unit)	Dietary pattern†					
	Time 1			Time 2		
	T1-P1	T1-P2	T1-P3	T2-P1	T2-P2	T2-P3
Whole grains	0.51	--	--	--	--	0.46
Non-whole grains	--	0.41	--	0.48	0.27	--
Dark green leafy vegetables	--	--	--	--	0.38	0.23
Deep yellow vegetables	--	--	0.40	--	0.40	0.31
White potatoes	--	0.21	--	0.29	--	--
Other starchy vegetables	--	--	−0.58‡	--	0.26	--
Tomatoes	--	0.44	--	--	--	0.56
Other vegetables	0.25	0.25	0.28	--	0.44	0.40
Citrus fruits, melons, and berries	0.39	−0.21	--	--	--	--
Other fruits	0.39	−0.25	0.32	--	--	--
Milk	0.29	--	--	--	--	--
Yogurt	−0.35‡	--	--	--	0.26‡	--
Cheese	0.32	0.36	−0.30	0.27	−0.42	--
Meat (beef, pork, veal, lamb, game)	−0.23	0.26	0.31	0.44	--	--
Frankfurters, sausage, lunch meats	--	0.31	--	--	--	--
Poultry (chicken, turkey, other)	--	--	0.28	0.29	0.20	−0.27
Fish (fish, shellfish, other)	--	0.28	--	--	0.56	--
Eggs	--	0.30	--	--	0.46	--
Cooked dry beans and peas	--	--	−0.51‡	--	--	−0.23‡
Soybean products	−0.29‡	--	--	--	--	−0.22‡
Nuts and seeds	0.47	--	--	--	--	--
Discretionary fat	0.36	0.66	--	0.82	--	--
Added sugars	0.49	--	--	0.40	--	--

† Factor loadings <0.20 were omitted for ease of interpretation. A variable with negative factor loading score has the characteristic opposite to the factor indicating people who score high on the factor would tend to eat less the food variable (i.e., negative correlation).

‡ Food group that transformed using negative power function (e.g. $y=x^{-0.25}$)(i.e., negative factor score indicates positive correlation).

Table 3

Comparison of total energy, body mass index percentile and z score among tertiles for each dietary pattern identified at Time 1 and Time 2 of adolescent females nine to 14 years on O‘ahu, Hawai‘i participating in the Female Adolescent Maturation Study (n=148)

Variable		Dietary pattern†					
		Time 1			Time 2		
		T1-P1	T1-P2	T1-P3	T2-P1	T2-P2	T2-P3
Pearson's correlation							
Total energy (kcal/day)		0.56***	0.66***	0.30***	0.72***	0.22***	0.13
BMI percentile		−0.30***	0.18*	0.04	0.06	−0.05	−0.22***
BMI z-score		−0.27***	0.19*	0.02	0.06	−0.08	−0.23***
Analysis of covariance, mean±SD‡							
Total energy (kcal/day)	Low	1559±380[a,b,c]	1527±356[a,b,c]	1695±435[b]	1453±380[a,b,c]	1685±393[b]	1795±495[c]
	Intermediate	1794±384	1728±326	1765±446	1786±281	1854±533	1731±482
	High	2048±429	2147±401	1941±419	2269±404	1967±497	1982±465
BMI percentile	Low	72.3±26.3[a,b]	55.5±29.2	60.4±27.2	56.5±27.8	60.2±26.1	63.7±25.5[b,c]
	Intermediate	57.9±27.6	61.5±29.5	58.3±31.9	58.9±29.5	57.5±28.7	63.7±27.4
	High	48.9±30.0	62.1±29.7	60.4±29.5	59.3±26.1	57.1±28.6	47.2±27.3
BMI z-score	Low	0.77±0.94[a,b]	0.16±1.03	0.35±0.90	0.18±0.97	0.35±0.85	0.46±0.88 [b,c]
	Intermediate	0.29±0.95	0.48±1.11	0.32±1.13	0.33±0.97	0.31±0.97	0.46±0.90
	High	0.03±1.15	0.44±1.02	0.41±1.14	0.31±0.87	0.17±0.98	−0.10±0.92

* $p<0.05$;

** $p<0.01$;

*** $p<0.001$

BMI: body mass index.

† Factor score of each dietary pattern was classified into three groups: Low (n=50), Intermediate (n=49), and High (n=49).

‡ Analysis of covariance was used to compare the tertile scorers for each dietary pattern, controlling for race with Tukey's post-hoc test as adjustment for multiple comparisons. Significant mean difference between two scorer groups is represented as follows: a=Low vs. Intermediate; b=Low vs. High; c= Intermediate vs High.