Published in final edited form as:

Int J Food Sci Nutr. 2009 ; 60(Suppl 3): 14–25. doi:10.1080/09637480802322095.

Eating patterns and overweight status in young adults: the Bogalusa Heart Study

NISHA A. MOHINDRA¹, THERESA A. NICKLAS¹, CAROL E. O'NEIL², SU-JAU T. YANG¹, and GERALD S. BERENSON³

¹ Baylor College of Medicine, USDA/ARS Children's Nutrition Research Center, Houston, Texas, USA

² Louisiana State University AgCenter, Baton Rouge, Louisiana, USA

³ Tulane Center for Cardiovascular Health, Tulane School of Public Health and Tropical Medicine, New Orleans, Louisiana, USA

Abstract

Several studies have focused on the association between eating patterns and obesity. However, the findings have not been consistent. The goal of the present study was to identify the eating patterns associated with overweight among young adults aged 19–28 years ($n = 504$) in Bogalusa, Louisiana. Food intake was determined using a single 24-h dietary recall, and height and weights were measured to determine the body mass index. The association between eating patterns and overweight status was evaluated using logistic regression and analysis of covariance. Twenty-four percent of young adults were overweight and 18% were obese; with the highest prevalence of obesity seen among black females. The percentage gram consumption of fruit/fruit juices ($P < 0.01$) was negatively associated with overweight status, and diet beverage consumption ($P < 0.05$) was positively associated with obesity. Eating patterns are associated with overweight status in young adults; however, the amount of variance explained in the body mass index was very small.

Keywords

Eating patterns; overweight; young adults; sweetened beverages; diet beverages

Introduction

In the United States, the incidence and prevalence of overweight and obesity continues to increase at alarming rates (Baskin et al. 2005). In young adults, over 57% of males and nearly 53% of females between 20 and 34 years are overweight or obese (Hoffmans et al. 1989). Obesity is a leading cause of preventable death in the United States (Abraham et al. 1971;

Correspondence: Theresa A. Nicklas, DrPH, Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, 1100 Bates Avenue, Houston, TX 77030-2600, USA. Tel: 1 713 798 7087. Fax: 1 713 798 7130. tnicklas@bcm.tmc.edu.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Kopelman 2000; Eckersley 2001); moreover, it has long been associated with increased risk for dyslipidemia and coronary heart disease (Hoffmans et al. 1989), premature death, stroke, type 2 diabetes mellitus (Abraham et al. 1971), metabolic syndrome (Gibson 1996), hypertension (Abraham et al. 1971), and some cancers (Kopelman 2000; Eckersley 2001).

Obesity has a strong genetic background (Bray and Popkin 1998); however, lifestyle factors are commonly considered to be the underlying cause of the increase in obesity by promoting or exacerbating it. While individual nutrients have been implicated in obesity (Gibson 1996; Bray and Popkin 1998; Macdiarmid et al. 1998; Zemel et al. 2000; Roberts et al. 2002), several studies have focused on identifying overall eating patterns. These studies have found associations between body mass index (BMI) and restaurant food consumption (Coll et al. 1979; Clemens et al. 1999), soft drink consumption (Ludwig et al. 2001), increased portion size (Hill and Peters 1998), meal patterns and meal frequency (Fabry et al. 1964; Kant et al. 1995a; Speechly et al. 1999; Ceru-Bjork et al. 2001), diet quality (Basiotis et al. 1998), and diet diversity (Kant et al. 1993).

Nicklas et al. (2003) have shown in children, however, that there was a lack of congruency in types of eating patterns associated with overweight status across ethnic-gender groups; further, that study and others demonstrated that the association between a single eating pattern and BMI explained very little of the variance in BMI (Nicklas et al. 2003; Storey et al. 2003; Forshee et al. 2004). Thus, more studies are needed to better understand the association between eating patterns and obesity.

Why target young adults? After leaving high school, young adults have a dramatic change in lifestyle (Baranowski et al. 1997, 1999). Independence brings responsibility and social pressures, and the family no longer dictates dietary habits. Pressures of independence, hurried lifestyles, and providing support for new families affect eating habits and diet quality. Skipping breakfast, reliance on fast-food sources, and convenience snacking with foods of low nutrient density contributes to the nutritional vulnerability of the group. Approximately 50% of the total gram amount of food consumed by young adults reflected low-quality foods (Demory-Luce et al. 2004). The anticipation of these young adults becoming food providers and consumer models for their young children makes evaluation of the eating patterns of this subgroup especially important. In this article, we identify the eating patterns (e.g. food consumption and meal patterns) associated with being overweight among young adults in the Bogalusa Heart Study (BHS).

Methods

Population

The BHS, which began in 1973, is a long-term epidemiologic study designed to examine the natural history of cardiovascular risk factors from childhood to adulthood in a well-defined biracial (black/white) population (Berenson 2001). A cross-sectional survey of young adults aged 19–28 years was conducted in 1989–1991. Individuals selected to participate in the dietary recall interview were those who had participated in the 1973–74, 1975–76 and 1977–78 birth cohorts and corresponded to those individuals who had 24-h dietary recalls collected in previous cross-sectional surveys when they were 10 year olds. There were no exclusionary criteria for participating in the dietary interview providing a signed consent form was received. Of the 533 eligible individuals who were screened, 95% consented to participate in the dietary recall interview. The total sample of 504 was 70% white and 58% female. Mean ages of the four race-gender groups ranged from 24.1 years (white males) to 23.2 years (black females), with males (23.9 years) significantly ($P<0.05$) older than females (23.3 years). The Louisiana State University and Tulane University Medical Centers' Institute Review Board approved the experimental plans, procedures, and consent forms for this study.

Dietary methodology

One 24-h dietary recall was collected on each participant. Quality controls included: use of a standardized protocol that specified exact techniques for interviewing, recording, and calculating results; collection of duplicate recalls on 10% of the population to assess interviewer variability; use of standardized graduated food models for quantification of foods and beverages consumed; development and use of a product identification notebook to stimulate recall of commonly forgotten foods, particularly between-meal snacks; and collection of family recipes (preparation methods and average portion sizes). Specifics of the dietary recall methods used in the BHS have been previously published (Frank et al. 1977; Farris and Nicklas 1993).

Nutrient database

The Extended Table of Nutrient Values (ETNV) originated in the early 1960s as one of the first nutrient databases in the United States (Moore and Goodloe 1982). The ETNV was the database used in the long-term BHS. In 1993, the ETNV—a mainframe designed computerized nutrient database system—was changed to a PC-based system (Champagne 2004). At the time of the present study, the ETNV included 5,000 core foods, beverages, and recipes, with values for 97 dietary components, including alcohol. The data bank was a flexible system permitting continuous updating of existing values and additions of new single or composite foods. Periodic updates were made to the ETNV to reflect nutrient changes in food products. Nutrient values include USDA data, other published references, manufacturers' information, and recipe calculation by ingredients.

Food groups

The food grouping scheme was designed for all foods or entries (core and recipe) appearing in the ETNV. Food types were identified for groups (e.g. cheese, as a major ingredient, was included in a food group list). Twenty-one major food groups were established, based on similar source characteristics (e.g. 'fruit and fruit juices' formed one major group; 'rice, biscuits, and cereals' were included in the breads and grains category). Composite food items, such as casseroles, were assigned to food groups according to primary ingredients. If no single food type (other than water) accounted for at least 60% of the weight, the item was classified as a mixed food. Examples of foods included in the food groups have been documented previously (Nicklas et al. 1990). Four food groups were deleted from the analyses due to very few or no participants consumed them, resulting in 17 food groups being included in the final analyses. The food grouping scheme was established when the BHS began in 1973. The protocol remained fixed for all of the dietary surveys that were conducted so that comparisons could be made over time in food group consumption (Nicklas et al. 2004).

Four larger food categories were created and used in the analyses: FJV (fruit, fruit juices, and vegetables); meats (mixed meats, poultry, seafood, eggs, pork, and beef); sweets (desserts, candy, and sweetened beverages); and dairy (milk and cheese). A diet diversity score (DDS) was also created (Kant et al. 1995b). The DDS reflected foods consumed from meats, dairy, breads/grains, fruit/fruit juices, and vegetable groups. The DDS ranged from 0 to 5, and reflected the number of the five major food groups consumed at least once in a 24-h period. For example, a score of 5 would indicate that an individual ate a food from all of the five food groups. The total number of eating episodes reflected the total number of meals plus snacks consumed as determined by the different time periods of each eating occasion.

The eating patterns selected for this study included food consumption patterns, total gram amounts of food/beverages consumed by meal period, total eating episodes, number of meals and snacks consumed, and a diet diversity score. The eating patterns were selected based on

an extensive review of the literature (Nicklas et al. 2001) and the eating patterns that could actually be extracted from the 24-h dietary recall.

Measure of adiposity

Height was measured twice to the nearest 0.1 cm on a standard board; weight was measured twice to the nearest 0.1 kg using a balance beam metric scale, and the two readings from each variable were averaged (Harnack et al. 1999). Individuals were grouped into three weight categories: normal weight ($\text{BMI} < 25 \text{ kg/m}^2$), overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$ and $\text{BMI} < 30 \text{ kg/m}^2$), or obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) (Berkey et al. 2004).

Statistical analysis

Analyses were performed using SAS 9.1 (SAS Institute Inc., Cary, NC, USA). Means, standard deviations, and percentiles were used to summarize the data. Food group consumptions were described as percentages of total gram intake, except for the total gram amount. The overall mean food group consumption differences among weight status (normal, overweight, and obese) were tested by analysis of covariance. If the overall mean differences were significant, Tukey's procedure was used for multiple comparisons. The association between overweight, obese, and each eating pattern variable was evaluated using logistic regression. Each model for overall effects included total energy intake, age, ethnicity, gender, and ethnicity $\times$ gender interaction as covariates to control for their potential effects on BMI. The test was statistically significant if $P < 0.05$.

An association between overweight, obese and a specific eating pattern was defined if the unity was not included in the 95% confidence interval of the odds ratio. The odds ratios presented in the following were calculated depending on the type of eating pattern construct. If the eating pattern was measured as percentage of total gram intake, then the odds ratio was the odds of being overweight, or of being obese if the participant increased 1% of total gram intake from that specific food group. For eating patterns not measured in grams, such as number of eating episodes, the odds ratio was the odds of being overweight, or of being obese if a participant had one more eating episode than his/her usual eating episodes per day. For example, the odds of being overweight for a young adult who had three meals instead of two meals per day were 0.89.

Results and discussion

Percentage of overweight young adults by ethnicity and gender

Results from this study add to those from previous studies that have used dietary intakes to establish associations between eating patterns and overweight status in young adults. Eighteen percent of the population was obese and 24% were overweight. A higher percentage of black females was either overweight or obese compared with white females (Table I). The prevalence of overweight among the young adults is comparable with the national average (Carnethon et al. 2004; Pereira et al. 2005).

The percentage gram consumption of fruits and fruit juices (eating pattern consumption as a percentage of total consumption) was negatively associated with being overweight ($P < 0.05$) while the percentage gram consumption of diet beverages was positively associated with being overweight ($P < 0.05$) and being obese ($P < 0.05$) (Table II). Correspondingly, normal weight individuals when compared with overweight individuals tended to have a higher percentage gram consumption of fruits and 100% fruit juices ($P < 0.05$), and less percentage gram consumption of diet beverages than obese individuals ($P < 0.05$). Obese participants consumed more food/beverage than normal weight participants ($P < 0.05$), because of the increased consumption of diet beverages. The negative association between fruit consumption and

overweight status has been reported in other studies (Lin and Morrison 2002; Nicklas et al. 2003), indicating that individuals whose diets contained more fruit had a lower BMI (Lin and Morrison 2002). The individual eating patterns explained only 1–2% of the variance in BMI. Contrary to what one would expect, the DDS did not differ by weight status. In a previous study, this score was found to be inversely associated with risk of mortality from cardiovascular disease, cancer, and other causes in a very large sample of adults (Kant et al. 1995b). The sample in our study may not be large enough to detect differences by weight status using a crude estimate of diet diversity.

In this study, the positive association between beverage consumption and overweight resulted from the consumption of diet beverages and non-sweetened beverages. This finding has also been reported in another study using national data (Forshee et al. 2004). The positive association between sweetened beverages and overweight in children and adults continues to be debated (Bachman et al. 2006). Studies supporting an association found that an increased consumption of sweetened beverages was associated with increased total energy intake (Harnack et al. 1999), particularly among overweight children and adolescents. However, many studies have shown either a weak association (Ludwig et al. 2001; Berkey et al. 2004; Newby et al. 2004; Schulze et al. 2004) or no association (Forshee and Storey 2003, 2004; Forshee et al. 2004). An important limitation of the early research is that it did not aggregate total carbonated soft drink consumption into regular and diet carbonated soft drink consumption. Moreover, Forshee and Storey (2004) have clearly demonstrated the importance of appropriate statistical evaluation and interpretation of data. Several studies have shown that when you aggregate soft drink consumption into regular and diet drinks, BMI was positively associated with diet carbonated beverages among children (Forshee and Storey 2003; Blum et al. 2005) and adolescents (Forshee and Storey 2003). The positive association between diet beverage consumption and overweight seen in our study and other studies is intuitively appealing, and it could be speculated that overweight individuals may drink diet beverages in an attempt to reduce their energy intake. The mechanism for increased diet soda consumption and increased BMI is unclear. A plausible explanation may be that as individuals become more overweight they tend to engage in more sedentary behaviors (Giammattei et al. 2003; Storey et al. 2003). Sedentary behavior such as watching television has been associated with changes in food and beverage consumption (Giammattei et al. 2003). An increase in diet soda consumption may be reflective of sedentary behaviors, such as decreased physical activity, that are associated with weight gain (Giammattei et al. 2003). Energy expenditure from physical activity directly influences the overall energy balance equation (Barlow and Dietz 1998). Physical activity was not assessed in this study. Thus, we cannot conclude that the findings of this study are independent of physical activity. More studies are needed looking at physical activity and diet in combination with regard to overweight status. The analyses controlled for energy intake to eliminate potential under-reporting that has been reported, by others, among overweight subjects (Johansson et al. 2001; Bailey et al. 2007). However, when we looked at energy adjusted intake of the foods, the associations no longer existed— suggesting that overweight individuals may also under-report the amount of foods consumed (Lafay et al. 2000; Becker and Welton 2001; Kant 2002).

It is important to note that the individual eating patterns explained only 1–2% of the variance in BMI. However, since the eating patterns studied were not mutually exclusive, it was impossible to determine the cumulative effect of the significant eating patterns on overweight status. One can hypothesize, however, that the association between eating patterns and overweight status is not a result of a single eating pattern, but of the combination of eating patterns that are interrelated and cumulative in their effect on overweight status. Moreover, these eating patterns associated with overweight may also vary by gender and ethnicity, further complicating the picture (Nicklas et al. 2003).

These results have important implications for designing obesity prevention research targeting young adults. These associations were poorly explained by a single eating pattern. Further research with multiple days of assessment is needed to better understand the associations among eating patterns and overweight status in young adults.

Our study does have some limitations. Since our study was a cross-sectional design, causal inferences cannot be made. Further, our findings may be specific to the young adults of Bogalusa and may not be representative of national findings. The dietary data were based on one 24-h dietary recall that may not be reflective of usual dietary intakes. However, the sample size was large enough to characterize group intakes. The dietary data are over 10 years old; however, they do provide an indication on the relationship between eating patterns and overweight status in young adults. The data used in this study were collected in 1989–1991 and may not be reflective of today's marketplace. However, it is acceptable to use long-term epidemiologic studies to address specific research questions. For example, in the past 5 years approximately 41 scientific papers were published using data from the Continuing Survey for Individual Intakes (CSFII 1989CSFII 1991CSFII 1994–1996–1998).

The nutrient database used in this study (i.e. the ETNV) reflected the foods and beverages consumed by young adults in 1989–1991 and may not be representative of the foods and beverages available today. The food grouping scheme used in this study was established when the BHS began in 1973. The protocol remained fixed for all of the dietary surveys that were conducted so that comparisons could be made over time on food group consumption (Nicklas et al. 2004). Although the food groups were based on their common source characteristics, the qualitative aspects of the food could not be separated out in the analyses (i.e. whole grains versus refined grains).

Conclusions

In this study, eating patterns were associated with overweight in young adults. However, the eating patterns explained only 1–2% of the variance in BMI. Thus, 97% of the variance is unexplained. More studies are needed to better understand how eating patterns in combination are associated with overweight before policy changes are made. Targeting single eating patterns in obesity intervention programs may not be the best approach. This is possibly reflected in the modest-to no-effect being observed with this approach.

Acknowledgments

This research was supported by grants from the National Heart, Lung, Blood Institute of the US Public Health Service (USPHS), Early Natural History of Arteriosclerosis R01 HL 38844, and the National Institute of Aging AG16592. Partial support for C.E. O'Neil came from HATCH Project #01999070 from the Louisiana State University Agricultural Center. This work is a publication of the United States Department of Agriculture (USDA/ARS) Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas, USA, and was also funded in part with federal funds from the USDA Agricultural Research Service under Cooperative Agreement No. 58-6250-6-003. The contents of this publication do not necessarily reflect the views or policies of the USDA, nor does mention of trade names, commercial products, or organizations imply endorsement from the US Government. The authors wish to thank Mrs Pamela Harris for help in preparing the manuscript and Mrs Bee Wong for librarian assistance. The BHS represents the collaborative efforts of many people whose cooperation is gratefully acknowledged. The authors also thank the children and adults of Bogalusa without whom this study would not have been possible.

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Table I

Percentage of overweight young adults by ethnicity and gender.

	Weight status			BMI [mean (standard deviation)]
	Normal weight [<i>n</i> (%)]	Overweight [<i>n</i> (%)]	Obese [<i>n</i> (%)]	
Ethnicity				
Whites	216 (61)	80 (23)	57 (16)	24.76 (5.16) ^A
Blacks	78 (52)	42 (28)	30 (20)	25.97 (6.25) ^B
Gender				
Male	123 (58)	52 (25)	35 (17)	25.33 (4.87)
Female	171 (58)	70 (24)	52 (18)	24.98 (5.96)
Ethnicity and gender *				
White-male ^{A, B}	84 (56)	38 (26)	27 (18)	25.59 (4.83) ^{A, B}
White-female ^A	132 (65)	42 (20)	30 (15)	24.16 (5.32) ^A
Black-male ^{A, B}	39 (64)	14 (23)	8 (13)	24.70 (4.96) ^{A, B}
Black-female ^B	39 (44)	28 (31)	22 (25)	26.84 (6.89) ^B
Total	294 (58)	122 (24)	87 (18)	25.12 (5.53)

Data with different uppercase superscript letters are statistically different.

* $P < 0.05$.

Table II

Association between eating patterns and weight status.

Odds ratio				Mean difference			
	Overweight vs normal weight	R ²	Obese vs normal weight	R ²	Normal weight	Overweight	Obese
Food groups I (gram percent)							
Fat	0.95 (0.84, 1.07)		0.96 (0.84, 1.10)		1.41 (0.12)	1.24 (0.18)	1.27 (0.21)
Fruits/fruit juices	0.96 (0.93, 0.99)	0.02	0.98 (0.96, 1.01)		6.36 (0.61)^A	3.60 (0.87)^B	4.80 (1.05)^{AB}
Vegetables	0.99 (0.97, 1.02)		1.01 (0.98, 1.03)		7.99 (0.58)	7.21 (0.83)	9.05 (1.00)
Breads/grains	1.00 (0.98, 1.03)		0.99 (0.95, 1.02)		10.21 (0.50)	10.36 (0.72)	9.64 (0.86)
Mixed meats	1.05 (0.99, 1.10)		1.04 (0.98, 1.11)		0.99 (0.25)	1.74 (0.36)	1.42 (0.43)
Dessert	0.99 (0.94, 1.04)		1.00 (0.95, 1.06)		2.26 (0.27)	2.17 (0.39)	2.30 (0.47)
Candy	0.99 (0.90, 1.08)		0.99 (0.78, 1.04)		1.33 (0.14)	1.25 (0.20)	0.85 (0.24)
Non-alcohol beverage	1.01 (0.99, 1.02)		1.01 (1.002, 1.03)	0.02	39.75 (1.37)^A	43.42 (1.97)^{A, B}	46.57 (2.36)^B
Diet beverage	1.02 (1.002, 1.03)	0.007	1.02 (1.001, 1.03)	0.01	2.57 (0.91)^A	5.56 (1.32)^{A, B}	6.80 (1.58)^B
Sweetened beverage	1.00 (0.99, 1.01)		1.01 (0.99, 1.02)		37.25 (1.54)	37.94 (2.23)	39.84 (2.67)
Poultry	0.99 (0.96, 1.03)		1.01 (0.98, 1.04)		3.59 (0.46)	3.32 (0.66)	4.06 (0.79)
Snack	0.95 (0.83, 1.08)		0.90 (0.76, 1.06)		0.86 (0.11)	0.77 (0.16)	0.56 (0.19)
Seafood	0.98 (0.94, 1.03)		0.98 (0.92, 1.03)		2.01 (0.34)	1.60 (0.50)	1.27 (0.59)
Condiments	1.09 (0.87, 1.38)		1.02 (0.77, 1.35)		0.50 (0.06)	0.57 (0.08)	0.52 (0.10)
Eggs	0.94 (0.83, 1.06)		0.93 (0.81, 1.07)		0.86 (0.13)	0.74 (0.18)	0.64 (0.22)
Milk	1.00 (0.98, 1.02)		1.00 (0.98, 1.03)		7.21 (0.75)	7.13 (1.09)	7.66 (1.30)
Pork	0.94 (0.87, 1.02)		0.93 (0.84, 1.03)		1.68 (0.19)	1.19 (0.28)	1.11 (0.33)
Cheese	1.00 (0.96, 1.04)		0.94 (0.87, 1.02)		2.11 (0.30)	2.04 (0.43)	1.17 (0.52)
Beef	1.03 (0.99, 1.07)		0.98 (0.93, 1.03)		3.43 (0.36)	4.51 (0.52)	3.09 (0.62)
Food groups II (gram percent)							
FIV	1.00 (0.99, 1.00)		1.00 (0.99, 1.001)		14.34 (0.84)^A	9.05 (1.20)^B	12.79 (1.44)^{AB}
Dairy	1.00 (0.98, 1.02)		1.00 (0.98, 1.02)		9.32 (0.80)	9.17 (1.16)	8.83 (1.38)
Meats	1.00 (0.98, 1.03)		0.99 (0.97, 1.02)		12.55 (0.64)	13.10 (0.93)	11.59 (1.11)
Sweets	1.00 (0.99, 1.01)		1.00 (0.99, 1.01)		40.84 (1.55)	41.36 (2.24)	42.99 (2.68)
Diet diversity score	0.89 (0.69, 1.14)		0.81 (0.62, 1.08)		3.66 (0.06)	3.57 (0.08)	3.53 (0.10)
Meal Period							
Breakfast	0.99 (0.97, 1.01)		1.01 (0.99, 1.03)		14.04 (0.87)	12.40 (1.25)	16.18 (1.50)
Lunch	1.01 (0.99, 1.02)		0.99 (0.98, 1.00)		25.76 (1.17)	28.41 (1.70)	22.48 (2.03)
Snack	1.00 (0.99, 1.01)		1.00 (0.98, 1.01)		29.62 (1.37)	30.41 (1.97)	27.46 (2.36)
Dinner	0.99 (0.98, 1.01)		1.01 (0.99, 1.02)		30.58 (1.08)	28.78 (1.56)	33.87 (1.86)
Total gram amount	1.00 (0.99, 1.01)		1.00 (1.00, 1.001)		2121.16 (48.30)^A	2117.32 (69.77)^{AB}	2346.70 (83.51)^B
Eating episode							
Number of meals	0.82 (0.60, 1.13)		0.91 (0.64, 1.30)		2.47 (0.04)	2.38 (0.06)	2.43 (0.08)
Number of snacks	0.97 (0.84, 1.12)		00.85 (0.70, 1.02)		2.37 (0.09)	2.30 (0.14)	2.01 (0.16)
Total eating episodes	0.93 (0.80, 1.08)		0.83 (0.69, 1.00)		4.84 (0.09)	4.68 (0.14)	4.44 (0.16)
Restaurant consumption	1.04 (0.99, 1.01)		1.01 (0.99, 1.02)		16.37 (1.59)	18.33 (2.31)	18.94 (2.75)

Model adjusted for age, calorie intake, ethnicity, gender, and ethnicity × gender. Data presented as the odds ratio (95% confidence interval) or as the least-square mean (standard error). Data with different uppercase superscript letters are statistically different. Data in bold are significant.