Measuring dietary acculturation in Japanese Americans with the use of confirmatory factor analysis of food-frequency data[1–3]

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ABSTRACT

Background: Epidemiologic evidence suggests that dietary changes associated with acculturation to a Western diet may increase the risk of type 2 diabetes in Japanese Americans.

Objective: We hypothesized that dietary acculturation patterns could be measured by confirmatory factor analysis (CFA) by using a culturally sensitive food-frequency questionnaire (FFQ). We examined the utility of the estimated factor scores by testing for associations with diabetes and 2 risk factors for diabetes—body mass index (BMI; in kg/m^2) and C-reactive protein (CRP).

Design: By using cross-sectional data from a sample of 219 Nisei (second-generation Japanese American; mean age 70 y) and 277 Sansei (third-generation Japanese American; mean age 42 y) participants in the Japanese American Family Study, we conducted CFA on 5 items characteristic of a Japanese diet and 4 items characteristic of a Western diet. The resulting factor scores were examined for associations with diabetes by using logistic regression and for associations with BMI and CRP by using linear regression.

Results: CFA confirmed the presence of Japanese and Western food factors. The Nisei had a significantly higher average factor score for the Japanese food factor and significantly lower average factor score for the Western food factor than did the Sansei. In Sansei persons, but not in Nisei persons, the Western food factor score was significantly associated with plasma CRP concentration ($P = 0.02$), BMI ($P = 0.02$), and diabetes ($P = 0.001$).

Conclusions: In this Japanese American sample, dietary acculturation can be estimated by using CFA on FFQ data. Future studies should investigate the effects of dietary acculturation on disease risk independent of other lifestyle factors. *Am J Clin Nutr* 2007;86:496–503.

KEY WORDS Dietary acculturation, Japanese American Family Study, confirmatory factor analysis, food-frequency questionnaire, FFQ, culture, Western diet, dietary patterns, diabetes, C-reactive protein, CRP

INTRODUCTION

Japanese Americans show greater rates of type 2 diabetes than do both white Americans (1, 2) and native Japanese (1, 3, 4). However, Japanese Americans who retain a Japanese lifestyle appear to be less prone to diabetes than are those who do not retain a Japanese lifestyle (5). Foreign-born Asian Americans with shorter US residency are at lower risk of being overweight or obese, both risk factors for diabetes, than are those with longer US residency (6). These observations suggest that the process of acculturation to a Western lifestyle may be contributing to differences in population risk.

Diet is an important risk factor for diabetes (7, 8); therefore, it may be valuable to measure the effects of dietary acculturation in addition to traditional diabetes risk factors. Dietary acculturation has been defined as the process by which immigrants and their descendents adopt the dietary practices of the host country (9). Assessment of dietary acculturation may also provide information about acculturation in a general sense.

Recent studies have identified several foods as either traditionally Japanese or traditionally Western. A study of Japanese Americans in the Los Angeles area (10) showed that Nisei (second-generation Japanese Americans, the offspring of immigrants) consumed greater amounts of tofu, rice, soy sauce, fish, tsukemono (pickled vegetables), and butter or margarine than did Sansei (third-generation Japanese Americans, the offspring of Nisei). The Sansei subjects, who presumably were more acculturated to a Western lifestyle, were more frequent consumers of cheese, salty snacks, and soft drinks than were the Nisei. In a study of native Japanese dietary patterns, exploratory factor analysis showed tofu, fish, and tsukemono to be traditional Japanese foods, whereas butter, margarine, beef, cheese, and chicken were determined to be Western foods (11). A third study showed that Japanese persons living in Japan consume more fish, eggs, and soy products (tofu included) and less animal meats and dairy than do Japanese Americans (12). These descriptive studies suggest specific foods that appear to be related to dietary acculturation in Japanese Americans; however, to date, an adequate tool has not

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been developed for measuring dietary acculturation among Japanese Americans.

In the present study, confirmatory factor analysis (CFA) was used to detect dietary patterns associated with traditional Japanese and Western diets in a community-based sample of Nisei and Sansei persons. We hypothesized that 2 latent variables, called "Western food factor" and "Japanese food factor," reflect the dietary habits of Japanese Americans. We also show the utility of the resulting estimated factor scores by testing the hypothesis that dietary acculturation is associated with diabetes status and 2 risk factors for diabetes—body mass index [(BMI; in kg/m^2) 4] and C-reactive protein [(CRP) 13, 14].

SUBJECTS AND METHODS

Study sample

The Japanese American Family Study is a community-based investigation of risk factors for type 2 diabetes, coronary heart disease, and metabolic syndrome in Japanese American families (15–17). Data for this study were collected from 1994 to 2002. Probands for the family study were recruited from participants in the Japanese American Community Diabetes Study [(JACDS) 18]. These persons were Nisei who were living in the Seattle area at the time of recruitment. Family members were recruited through the proband. For this analysis, eligible family members included the proband's siblings, offspring, nieces, and nephews, as well as the spouses of these family members. Data were collected from 309 Nisei and 327 Sansei persons. Data were collected from few first- and fourth-generation persons, and those samples were not large enough for analysis.

All study participants provided written informed consent. The University of Washington Institutional Review Board approved the present study.

Food-frequency data

A food-frequency questionnaire (FFQ) was self-administered in the family study to 224 Nisei and 282 Sansei (506 total subjects). This FFQ contained 40 items and was a shortened version of the 89-item FFQ originally developed for the JACDS (19). This reduction in the number of items was made because of the length of time required to complete the full FFQ and process the resulting data. The reduction process was conducted by 3 dietitians with extensive knowledge of Japanese dietary patterns after the full FFQ had been administered to >700 persons in the JACDS.

A subset of 10 of the 40 items in the full FFQ was used in the present analysis. The choice of specific food items for inclusion in the CFA was based on 2 studies that highlighted the dietary differences between Japanese and Western culture (*see* Introduction) (10, 11). A more general study of broad food groups was used to confirm these choices (12). Tofu, rice, soy sauce, fish, and tsukemono were selected as representative Japanese foods, and cheese, snacks (snack chips, crackers, and popcorn), soda, poultry, and beef were chosen as representative Western foods. Food items that were not consistently associated with either the Japanese or the Western diet across all available studies, such as butter or margarine, were not used. Some Japanese foods, such as seaweed and green tea, and some Western foods, such as yogurt and coffee, were not specifically measured in the FFQ for this study and thus were not incorporated into the analysis.

All FFQ items, including the 10 selected items, were reported as open-ended responses measured in servings per day; serving size was determined with the use of NUTRITION DATA SYSTEM software (version 4.05; The Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). For each item, outliers were defined as observations that fell >2 SDs beyond the next largest observation. After removing outliers, a Box-Cox transformation was used on each food item to reduce deviations from normality. Optimal λ values for each transformation were calculated by using a maximum-likelihood procedure implemented in the SAS %BOXCOXAR macro program (version 9.1; SAS Institute, Cary, NC).

Biological and anthropometric measurements

Fasting blood samples were collected from 1994 to 2002. The method for CRP measurement was reported previously (17). Briefly, CRP was measured in 2003 from fasting blood samples of 574 study subjects in the Department of Laboratory Medicine at the University of Washington with the use of a high-sensitivity immunonephelometric method (20). Measurements were performed with the use of 310 frozen samples of blood stored in EDTA and with 264 frozen, citrated blood samples. Because of the different volumes of anticoagulant in the citrated samples and in samples in the EDTA-coated tubes, a dilution factor of 1.17 was applied to the CRP measurements from citrated blood samples.

Diabetes status was defined by either *1*) physician-prescribed insulin or oral medication for diabetes or *2*) a fasting glucose concentration $\geq$ 126 mg/dL. A self-administered questionnaire was used to obtain demographic and medical history information from study participants. This information included smoking status and history of myocardial infarction, coronary artery disease, hypertension, and diabetes. Participants also provided information on medications, including those known to lower CRP concentrations (aspirin, β-blockers, fibrates, niacin, and statins), oral contraceptives and hormone replacement therapy in women, and diabetes medications. For local participants, height (cm) and weight (kg) were measured by a trained study technician. For nonlocal participants ($\approx$50% of subjects), self-reported height and weight were obtained from the questionnaire. BMI was calculated.

Confirmatory factor analysis

We hypothesized 2 latent factors—a Japanese food factor and a Western food factor. We then assessed the convergent validity of the group of foods chosen to measure each factor by examining the covariance structure within each group (21). CFA was then performed with the use of the CALIS procedure in SAS to verify the hypothesized factor structure (21). In CFA, the food items were allowed to load on only one factor, and loadings were fixed at zero for the other factor. The maximum-likelihood parameter estimation method was used to estimate the variances of residual terms for food item variables, covariance between factors, and the estimated factor loadings. The goodness of fit for a CFA is determined by using the comparative fit index (CFI) and the nonnormed fit index (NNFI). By convention, a CFI $\geq$ 0.90 and an NNFI $\geq$ 0.90 indicate an acceptable fit (21). The fit of the model is also judged by the root mean square error of approximation (RMSEA). By convention, an RMSEA $<$ 0.1 indicates a good fit (21). Hu and Bentler (22) suggested more stringent

cutoffs of 0.95 for NNFI, 0.95 for CFI, and 0.06 for RMSEA. A *t* test is used to judge the significance of each individual food item's relation to its factor; the threshold used to determine whether an item loads on a factor is 3.29, corresponding to $P = 0.001$.

With the use of the CFA structure, estimated factor scores were generated for each study subject as follows. Values for each of the 9 food items included in the Japanese or Western factors were standardized by subtracting the mean and dividing by the SD for each food item. Means and SDs for each item were calculated with the use of the entire CFA sample ($n = 496$). For each person, the standardized values of the foods loading on each factor were summed and divided by the number of foods loading on the specific factor. No food-specific weights were used because the factor loadings for each of the items were similar. The resulting estimated factor scores represent the extent to which a subject adhered to each of the 2 dietary patterns. These scores were compared between generations by means of a 2-sample, equal-variance *t* test. Histograms were generated for each factor score within generations, and fitted normal curves were superimposed for ease of comparison with the use of the histogram procedure in STATA software (version 8; Stata Corp, College Station, TX).

Association analyses

Because of differences in age distributions, the Nisei and Sansei groups were analyzed separately (10). The factor scores were tested for associations with CRP, BMI, and diabetes status. All CRP values > 10 mg/L were excluded because these values indicate acute-phase responses (17). Because of high skewness and kurtosis values, CRP values were log transformed before the analysis (skewness: 2.52 before transformation compared with 0.03 after; kurtosis: 7.3 before compared with −0.65 after). A Box-Cox transformation ($\lambda = -1.13$) was used to reduce the skewness and kurtosis of the BMI distribution (skewness: 0.91 before compared with −0.02 after; kurtosis: 1.59 before compared with −0.26 after). A mixed linear model (implemented as PROC MIXED in SAS) was used to test for associations with CRP and BMI, which both allowed and accounted for correlations among family members. Both association analyses were adjusted for age, sex, oral contraceptive use, hormone replacement therapy use, smoking status, diabetes, history of myocardial infarction or coronary artery disease, and hypertension. Logistic regression analysis was adjusted for age and sex, and transformed BMI was used to test for associations with diabetes. To account for possible correlations among family members, associations with diabetes were also tested with the use of a binary regression, again with the use of the mixed linear model.

RESULTS

Sample characteristics

FFQ data were available for 506 persons. Ten persons were identified as outliers for ≥1 food items and excluded from the analysis. The resulting sample size for CFA was 496 subjects. There was a slightly greater proportion of women (56.3%) than of men and a greater number of Sansei ($n = 277$) than of Nisei ($n = 219$). The mean age for Nisei and Sansei was 69.8 ± 8.1 and 41.8 ± 7.9 y, respectively. For the subsequent association analyses, the 468 persons from the CFA sample with complete information for BMI, diabetes, and CRP were included. Characteristics of 2 subsamples used in these stratified association analyses (Nisei and Sansei) are provided in **Table 1**.

TABLE 1
Characteristics of the Japanese American Family Study (1994–2002) subsample used for association analyses ($n = 468$)[1]

	Nisei ($n = 209$)	Sansei ($n = 259$)
Sex (% women)	57.9	53.3
Age (y)	69.8 ± 8.0[2]	41.8 ± 8.0
BMI (kg/m^2)	24.6 ± 3.4	24.3 ± 3.6
Cigarette smoker (%)		
Current	5.7	8.9
Former	43.5	22.4
Never	50.8	68.7
Myocardial infarction or coronary heart disease (%)	12.0	0.4
Hypertension (%)	48.3	11.6
Diabetes (%)	17.7	3.5
CRP-lowering medication[3] (%)	40.2	10.4
Oral contraceptive use[4] (%)	0.0	15.2
Hormone replacement therapy[4] (%)	48.8	10.9
CRP (mg/L)	1.69 ± 1.86	1.00 ± 1.22

[1] Nisei are second-generation Americans, offspring of Japanese immigrants; Sansei are third-generation Americans, offspring of Nisei.
[2] $\bar{x}$ ± SD (all such values).
[3] Aspirin, β-blockers, fibrates, niacin, or statins.
[4] Percentages are for women only.

Confirmatory factor analysis

After removal of outliers (*see* Subjects and Methods), the distribution of each of the food items still showed high skewness and kurtosis (**Table 2**). This was due mainly to high frequencies at 0 servings/d for all food items. The Box-Cox transformation greatly reduced the skew and kurtosis (**Appendix A**), and the distributional assumptions for CFA were adequately addressed (21). A correlation matrix of all food items is shown in **Table 3**. The poultry and beef or pork variables were combined into a "meat" item for 2 related reasons: *1*) the observed correlation between the poultry and beef or pork items was noticeably weaker than all other pairwise correlations within the group of foods chosen to measure the Western food factor ($r^2 = 0.15$); and *2*) poultry and beef are substitutes for one another, which explains the weak correlation. In light of the strong correlations of both beef or pork and poultry with other Western foods (≈0.25), the 2 items were combined. This eliminated the weak correlation, retained information associated with both items, and improved the convergent validity of the Western food items (ie, their ability to measure the same construct, the Western food factor).

CFA results are shown in **Table 4**. All standardized coefficients (ie, factor loadings) were >0.45, and the associated *t* tests indicated that the loading of each food item was significantly different from zero. CFA produced a CFI and an NNFI of 0.930 and 0.904, respectively, both of which were above the 0.90 thresholds for an acceptable fit. The RMSEA value was 0.057, which was below the 0.1 threshold for an acceptable fit. The correlation between the 2 factors was weak (−0.03) and not significantly different from zero, as measured by a *t* test.

A comparison of Nisei and Sansei showed that the means of both Japanese and Western scores differed significantly between

TABLE 2
Characteristics of the distribution of untransformed and transformed food-frequency questionnaire items[1]

	Untransformed values			Transformed values			
Food item	$\bar{x} \pm$ SD	Skewness	Kurtosis	$\bar{x} \pm$ SD	Skewness	Kurtosis	λ
Japanese diet (servings/d)							
Fish	0.28 ± 0.24	2.09	6.56	0.16 ± 0.09	0.08	−0.51	−2.4
Rice	0.90 ± 0.64	2.04	6.82	0.47 ± 0.19	−0.01	0.09	−0.7
Tsukemono	0.16 ± 0.30	3.23	13.45	0.05 ± 0.06	0.63	−1.02	−5.6
Tofu	0.18 ± 0.22	2.57	10.11	0.10 ± 0.07	0.21	−0.95	−3.8
Soy sauce	0.53 ± 0.45	1.77	4.96	0.29 ± 0.15	0.06	−0.77	−1.2
Western diet (servings/d)							
Cheese	0.22 ± 0.29	3.14	14.05	0.10 ± 0.08	0.27	−0.96	−3.6
Meat	1.16 ± 0.67	1.48	4.36	0.65 ± 0.24	−0.13	0.02	−1.0
Beef or pork	0.61 ± 0.52	2.04	6.34	0.33 ± 0.17	0.05	−0.45	−1.0
Poultry	0.54 ± 0.37	1.49	3.77	0.32 ± 0.14	0.01	−0.36	−1.0
Snacks	0.26 ± 0.24	1.34	1.29	0.14 ± 0.09	0.17	−0.91	−2.7
Soda	0.72 ± 1.02	2.33	6.37	0.25 ± 0.21	0.32	−1.25	−1.4

[1] Food items were transformed by using the Box-Cox transformation ($n = 496$): $f(x, \lambda) = (x^{\lambda} - 1)/\lambda$, where $x =$ servings per day and λ is the transformation parameter (estimated by maximum likelihood). Skewness and kurtosis values of zero indicated normality.

the 2 groups (**Figures 1** and **2**). On average, Nisei had higher estimated Japanese food factor scores than did Sansei, whereas Sansei had higher estimated Western food factor scores than did Nisei. However, the generational distributions of both estimated factor scores were quite broad, and there was a substantial amount of overlap.

Association results

Complete information on CRP, BMI, diabetes, factor scores, and covariates was available for 209 Nisei and 259 Sansei. In the Sansei but not in the Nisei, the Western food factor score was significantly associated with increasing lnCRP, Box-Cox–transformed BMI, and diabetes prevalence (**Table 5**). When examined by quintile, the Western factor score's effect on lnCRP appears to be nonlinear ($P = 0.04$, test for homogeneity). However, the inclusion of adjustments for BMI in the regression model reduced the effect of the continuous Western factor score on lnCRP to a nonsignificant level ($P = 0.2$). In the Sansei, the Western food factor was also associated with diabetes status (odds ratio: 12.96; 95% CI: 2.97, 56.57), and adjustment for BMI did not affect the magnitude of this association. Binary regression analysis with adjustment for familial correlations resulted in a similar significance level, which suggests that familial correlations do not account for this association. lnCRP, Box-Cox–transformed BMI, and diabetes were not associated with the Japanese food factor score in either generation (data not shown).

DISCUSSION

The present study developed a measurement tool for dietary acculturation in the Japanese American Family Study. A Japanese factor score and a Western factor score were generated for each person, and those scores reflected the extent to which a traditional Japanese and a typical Western diet were being consumed. On average, the Nisei subjects had higher Japanese food factor scores and lower Western food factor scores than did the Sansei. However, the generational distributions of factor scores are quite broad for both factors. Furthermore, the generational distributions overlap significantly for both factors. These observations suggest that a generation is a crude proxy for dietary

TABLE 3
Correlation matrix of Box-Cox–transformed servings per day of the 9 food items used for confirmatory factor analysis[1]

	Food item number (from left column)								
Food item	1	2	3	4	5	6	7	8	9
Japanese diet									
1) Fish	1.0	0.23	0.31	0.34	0.23	−0.08	0.10	0.00	0.01
2) Rice		1.0	0.30	0.36	0.38	−0.06	0.06	0.00	−0.05
3) Tsukemono			1.0	0.39	0.42	−0.04	0.03	0.03	−0.08
4) Tofu				1.0	0.36	−0.10	−0.06	−0.25	−0.13
5) Soy sauce					1.0	0.04	0.11	0.13	−0.04
Western diet									
6) Cheese						1.0	0.28	0.28	0.19
7) Meat							1.0	0.25	0.34
8) Snacks								1.0	0.26
9) Soda									1.0

[1] Gray areas indicate that correlations between items were hypothesized to load on the same factor ($n = 496$).

TABLE 4
Standardized factor loadings for confirmatory factor analysis ($n = 496$)[1]

Food item	Japanese food factor	Western food factor
Fish	0.46[2]	0
Rice	0.55[2]	0
Tsukemono	0.63[2]	0
Tofu	0.64[2]	0
Soy sauce	0.61[2]	0
Cheese	0	0.46[2]
Meat	0	0.59[2]
Snacks	0	0.49[2]
Soda	0	0.53[2]

[1] Correlation between factors was −0.03 ($P > 0.05$).
[2] Significantly different from zero, $P < 0.001$ (t test).

acculturation and that there is substantial intragenerational variability in dietary acculturation levels.

These 2 latent dietary factors are uncorrelated, which implies that a person with a high Japanese food factor score is no more likely to have a low Western food factor score than is a person with a low Japanese food factor score. This observation is consistent with the current understanding that acculturation, when measured in terms of ethnic or cultural identification, is a multidimensional construct in which persons can identify highly with multiple cultures, rather than a one-dimensional continuum in which a person's level of identification with one culture is inversely correlated with his or her identification with another culture (23). This similarity between cultural identification measures and the dietary factors detected here supports the hypothesis that dietary acculturation reflects, or is strongly associated with, more traditional measures of ethnic or cultural identification. However, the present study could not directly test that hypothesis.

CFA was used in the present study, rather than the more common exploratory approach, because the study was not exploratory in nature. We specifically hypothesized the existence of 2 latent factors and the combinations of individual food items that would load on each factor before the analysis. CFA was used to test our hypothesis.

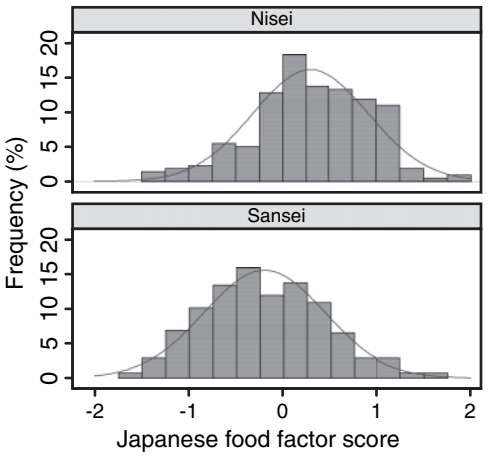

FIGURE 1. Frequency distributions of estimated Japanese food factor scores plotted by generation, with a normal curve superimposed. Mean factor scores for Nisei (30 ± 0.62; $n = 219$) and Sansei (-0.20 ± 0.64; $n = 277$) were significantly different ($P = 0.001$; equal variance t test).

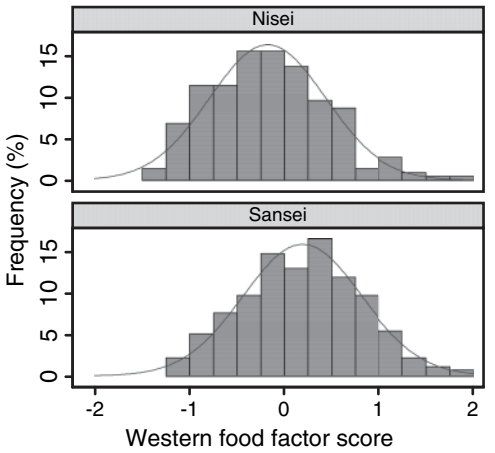

FIGURE 2. Frequency distributions for estimated Western food factor scores plotted by generation, with a normal curve superimposed. Mean factor score for Nisei (-0.18 ± 0.61; $n = 219$) and Sansei (0.19 ± 0.63; $n = 277$) were significantly different ($P = 0.001$; equal variance t test).

The present study also showed that the consumption of a diet rich in Western foods is significantly associated with plasma CRP concentration, BMI, and diabetes status in the Sansei generation but not in the Nisei generation. The association between the Western food pattern and CRP appears to be at least partially due to confounding by BMI. Previous studies with the use of exploratory factor analysis methods on FFQ data in US populations have detected a Western food factor composed of food items such as processed meats, red meat, sweets, desserts, French fries, high-fat dairy, and refined grains (24–27). The Western food factor was shown to be associated with CRP in a study of women (26), associated with diabetes in a study of men (27), and associated with various cardiovascular disease endpoints in studies of both women and men (25, 28). These associations are consistent with those found for the Western food factor measured in the present study. A Japanese food factor was detected in a study of Japanese men, and it was shown to be positively associated with impaired glucose tolerance (29). The present study, although not designed to detect associations with glucose tolerance, did not find a relation between diets with higher levels of Japanese indicator foods and diabetes status.

Many specific nutrients, foods, and diet types have been analyzed in relation to chronic CRP concentrations with the use of a variety of study designs. Inverse associations were reported between CRP concentrations and dietary fiber (30–33), fish oil (34), magnesium (35, 36), α-linolenic acid (37), n−3 fatty acids (38), and arginine (39). However, a recent meta-analysis indicated that the evidence for the CRP-lowering effects of n−3 fatty acids and α-linolenic acid is still inconclusive (40). Evidence also suggests that the consumption of fish (41), moderate amounts of alcohol (42), fruit and vegetables (43), carbohydrate-restricted diets (44, 45), and calorie-restricted diets (46) is associated with lower serum CRP concentrations. Our findings suggest that dietary effects on diabetes, CRP, and BMI may be more closely associated with the presence of Western food patterns than with the absence of traditional Japanese dietary patterns. The factor scores detected here did not specifically capture any dietary variables—except fish—that were previously reported to be associated with CRP (30–46).

TABLE 5
Untransformed BMI and plasma C-reactive protein (CRP) concentration and frequency of diabetes for Nisei and Sansei persons, shown by quintile (Q) of age- and sex-adjusted Western food factor scores[1]

	Western food factor score					
	Q1 (lowest)	Q2	Q3	Q4	Q5 (highest)	*P*
BMI (kg/m^2)						
Nisei	24.2 ± 3.4[2]	24.2 ± 2.9	24.2 ± 3.1	24.9 ± 3.7	25.7 ± 3.8	0.16[3]
Sansei	23.7 ± 3.5	23.9 ± 3.4	24.6 ± 4.1	24.4 ± 3.9	25.0 ± 3.3	0.02[3]
CRP (mg/L)						
Nisei	1.61 ± 1.54	1.31 ± 1.19	2.03 ± 2.14	1.76 ± 2.38	1.76 ± 1.81	0.47[3]
Sansei	0.60 ± 0.64	1.21 ± 0.95	1.10 ± 1.22	1.13 ± 1.61	1.15 ± 1.40	0.02[3]
Diabetes						
Nisei (%)	8.0	6.0	2.0	11.0	10.0	0.05[4]
Sansei (%)	0.0	1.0	0.0	3.0	5.0	0.001[4]

[1] Nisei, $n = 209$; Sansei, $n = 259$.
[2] $\bar{x} \pm$ SD (all such values).
[3] *P* values obtained from a linear regression on transformed variables, Box-Cox(BMI) and ln(CRP). Independent variables included the continuous Japanese food factor score, the continuous Western food factor score, age, sex, oral contraceptive use, hormone replacement therapy, smoking status, diabetes, history of myocardial infarction or coronary artery disease, and hypertension.
[4] *P* values were obtained from a logistic regression that included the continuous Japanese food factor score, the continuous Western food factor score, age, and sex.

Our measurement method is limited by its reliance of traditional FFQ data (ie, frequencies of food types). Satia et al (47) measured dietary acculturation in Chinese Americans and Chinese Canadians with the use of 2 scales developed through qualitative studies of dietary habits. Those scales incorporate specific aspects of the diet that are not reflected in the content of the FFQ used in the present study (ie, food preservation techniques, temporal diet patterns, eating out, and food temperatures). Moreover, evidence suggests that a Western diet is characterized by eating between meals, eating out, and skipping breakfast (10). Our analysis is also limited to the types of foods contained in the FFQ. Consequently, the food items selected for the present analysis were intended to be representative, rather than comprehensive, in characterizing traditional Japanese and Western diets. Future applications of this method in Japanese American populations could use additional or different foods to measure dietary acculturation, assuming that the measurement model was supported by the scientific literature and confirmed with the use of CFA. An FFQ specifically designed to focus on dietary acculturation may be more useful in characterizing these factors in a more comprehensive manner. Such an FFQ could be designed through qualitative studies that investigate the content of the Japanese and Western diets from the perspective of Japanese Americans.

Additional limitations of the present study include the lack of data on confounders such as cultural identification and physical activity. Assuming that dietary acculturation is associated with broad measures of acculturation (or cultural identification), it is possible that the risks associated with dietary acculturation are confounded by other risk factors also associated with broad measures of acculturation, such as physical activity. Without data on these potential confounders, we cannot measure the degree to which confounding occurs or the strength of the association between dietary acculturation and cultural identification.

In conclusion, CFA was used to confirm the existence of 2 latent factors that reflect dietary habits in Japanese Americans. Factor scores were estimated for each person in this sample, and they represented the degree to which each person consumes Japanese and Western diets. These scores show statistically significant differences between generations, which supports the hypothesis that these scores reflect dietary patterns that are a part of the acculturation process. Estimated Western food factor scores were shown to be associated with plasma CRP concentration, BMI, and diabetes status in the Sansei generation. Additional research is needed to determine *1*) how well this measure of dietary acculturation corresponds to broader measures of acculturation, *2*) how generalizable this measure and its associations are in other Japanese American populations, *3*) whether the observed associations are causal, and *4*) whether these associations are confounded by other risk factors. Future studies of diabetes in populations descended from immigrants should consider investigating the effects of dietary acculturation independent of other lifestyle changes. Information on dietary acculturation patterns and associated disease risks may help public health practitioners design interventions that aim to improve health outcomes among the descendants of immigrants.

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The American Journal of Clinical Nutrition

APPENDIX A

Box-Cox–transformed food-frequency questionnaire items, stratified by generation[1]

Food item	Nisei (n = 219)	Sansei (n = 277)	P[2]
Japanese diet			
Fish	0.18 ± 0.08[3]	0.14 ± 0.09	<0.0001
Rice	0.51 ± 0.18	0.44 ± 0.18	<0.0001
Tsukemono	0.08 ± 0.06	0.04 ± 0.05	<0.0001
Tofu	0.12 ± 0.06	0.08 ± 0.07	<0.0001
Soy sauce	0.32 ± 0.16	0.26 ± 0.15	<0.0001
Western diet			
Cheese	0.08 ± 0.07	0.12 ± 0.08	<0.0001
Meat	0.60 ± 0.24	0.69 ± 0.23	<0.0001
Beef or pork	0.32 ± 0.18	0.34 ± 0.16	0.10
Poultry	0.28 ± 0.14	0.35 ± 0.14	<0.0001
Snacks	0.12 ± 0.09	0.16 ± 0.09	<0.0001
Soda	0.20 ± 0.20	0.29 ± 0.21	<0.0001

[1] Food items are transformed by using the Box-Cox transformations (λ values given in Table 2).

[2] P values were determined by using an equal-variance t test.

[3] $\bar{x}$ ± SD (all such values).