

Improved Dietary Variety and Adequacy but Lower Dietary Moderation with Acculturation in Chinese Women in the United States

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ABSTRACT

Acculturation is associated with increased chronic disease risk among Asian Americans, but its association with different aspects of diet quality remains unclear. Associations of acculturation with diet quality were examined in a convenience sample of 243 Chinese participants in a study of diet and mammographic density in the Philadelphia region between January 2002 to May 2003. An acculturation index was created based on self-reported English proficiency and within- and cross-ethnicity social interactions. Diet Quality Index-International (DQI-I) scores were based on responses to an 88-item food frequency questionnaire. Odds ratios (ORs) for falling into a higher vs lower quartile for DQI-I and its components (ie, variety, adequacy, moderation, balance) were estimated with logistic regression analysis for polytomous outcomes. In the sample, mean age was 53.2 (standard deviation=10.5) years, body mass index (calculated as kg/m²) was 24.1 (standard deviation=3.5), and acculturation was significantly associated with improved dietary variety (OR: 2.4; 95% confidence interval [CI]: 1.5 to 3.8) and adequacy (OR: 1.6; 95% CI: 1.0 to 2.6) and lower dietary moderation (OR: 0.6; 95% CI 0.4 to 0.9), but these associations were evident only among women with less than a high school education. Acculturation and education were not associated with overall diet quality or balance. Although an association of less dietary moderation with acculturation suggests the likely importance of acculturation-related dietary change to chronic disease risk, these findings highlight the need for flexible dietary interventions among immigrant populations to discour-

age the adoption of some new dietary habits, while encouraging the retention of other, traditional ones.

Rates of metabolic disorders, cardiovascular diseases, and certain cancers are lower in China than in the United States, but increase among Chinese immigrants to the United States (1-9). Acculturation into mainstream US culture has been associated with a decrease in diet quality, which may contribute to increased risk for chronic diseases among Asian Americans (5,10-12). However, some studies note substantial increases in consumption not only of fats and sweets, but also of grains, dairy products, fruits, and vegetables (13-15). Thus, the effect of acculturation on dietary intake is likely more complex than suggested in previous work.

Although most studies examine single nutrients and foods or food groups, few examine acculturation in relation to indicators of diet quality. Indexes such as the Diet Quality Index (16) and Healthy Eating Index (17) provide quantitative measures of overall intake relative to dietary guidelines and have been associated with chronic disease risk and mortality (18,19). The Diet Quality Index-International (DQI-I) (20) is a composite measure of four aspects of diet quality (ie, variety, adequacy, moderation, and balance) that allow for identification of aspects of diet that warrant improvement.

The present study examined the association of acculturation with diet quality and its components in a sample of US Chinese immigrant women. The analysis is the first to investigate how acculturation is related to different aspects of diet quality among immigrants undergoing the transition from low to high chronic disease risk. Because acculturation is correlated with level of education (21), stratified analyses were also conducted to quantify associations for acculturation independent of level of education.

METHODS

Study Sample

Participants were US Chinese women who gave their written, informed consent to participate in a cross-sectional study on diet and breast density (21). Between January 2002 and May 2003, 250 women were recruited from community organizations and contacts, mammography screening programs, and newspaper advertisements in the Philadelphia, PA, region. Women were eligible if they were of Chinese heritage, were 40 years or older, and had received a mammogram within the previous 3

months. Exclusion criteria included history of breast augmentation or reduction, prophylactic mastectomy or any cancer except nonmelanoma skin cancer, breastfeeding currently or within last 9 months, and current pregnancy. Participants received \$20 as reimbursement for their time. The study was approved by the Fox Chase Cancer Center (Philadelphia, PA) Institutional Review Board.

Data Collection

Health history and food frequency questionnaires (FFQs) were interviewer- (n=184) or self- (n=66) administered in English or Chinese. Level of acculturation was quantified using a scale that assessed two dimensions of acculturation; ie, adult English proficiency and level of interaction with members of mainstream society (structural assimilation) (22). To assess adult English proficiency, participants gave one of five possible responses ranging from Chinese only to English only (coded 1-5) to three separate questions of what language they preferred to speak, read, and write (23). Structural assimilation included three questions on primary relationships (eg, neighbors, close friends, and coworkers), each assessed on a three-level scale (coded 1-3) ranging from mostly/all to few/none Chinese. An acculturation score was calculated as the sum of the scores for the six questions, with values ranging from 6 (least acculturated) to 24 (most acculturated). Values were imputed for each of the two acculturation dimensions separately, for two women who responded to two of the three questions on English proficiency and for 72 women who responded to two of the three questions on structural assimilation, by using the mean of the two nonmissing responses. Of the 72 women for whom we imputed a structural assimilation score, 56 were missing the response for coworkers' ethnicity because they were unemployed at the time. Odds ratio (OR) estimates were similar when the sample was limited to 172 women with complete data on all six questions and when we quantified level of acculturation based only on English proficiency among the 241 women with complete responses for those three questions.

Dietary intake was assessed using an FFQ designed for the target population (24). Women reported their frequency of intake over the last year of 88 foods and beverages, including Chinese as well as American items, and selected a usual portion size from four choices. A nutrient database was compiled by Health Technomics, Inc (Annandale, VA) (25), derived from the US Department of Agriculture's database used in the 1994-96 Continuing Survey of Food Intakes by Individuals (26) and Release 12 of the US Department of Agriculture's Nutrient Database for Standard Reference (27), both updated using the

US Department of Agriculture's provisional carotenoid tables (28). Nutrient intake was estimated as the product of each food's consumption frequency and amount (in specified units), grams per unit, and nutrient content per 100 g, summed over all food items. All questionnaires were administered by a single, trained interviewer who also reviewed them for completeness and accuracy upon their completion or receipt.

Assessment of Diet Quality

The DQI-I (29) captures four facets of diet quality related to under- as well as over-nutrition: dietary variety within protein sources (meat, poultry, fish, dairy, beans, eggs) and across food groups (meat/poultry/fish/eggs, dairy/beans, grains, fruits, vegetables); adequacy of intake of eight key food groups and nutrients (vegetables, fruits, grains, fiber, protein, iron, calcium, and vitamin C) relative to recommended intakes; moderation of intake of five factors (total fat, saturated fat, cholesterol, sodium, and empty calorie foods) related to chronic disease development; and overall balance with respect to macronutrients and fatty acid composition (29). Servings per day reported on the FFQ were adjusted to match the US Food Guide Pyramid serving size definitions (30). Details on components of the DQI-I and scoring criteria are given in the Figure.

Statistical Methods

Analyses included 243 women with information on acculturation, education, and dietary intake. Overall DQI-I score and its four components were examined as outcomes variables using SAS (version 8.01, 1999, SAS Institute, Cary, NC). Acculturation score was dichotomized at the approximate median (≤ 9 or > 9) to represent lower and higher levels of acculturation. Level of education was categorized into three groups (less than high school, high school completion, and college degree or higher) that were subsequently collapsed to insure adequate numbers for stratified analyses. In bivariate analyses, demographic characteristics were compared across acculturation categories using Cochran-Mantel-Haenszel test statistics for categorical data (expressed as percent in each category) and *t* tests for continuous variables (expressed as mean [standard deviation (SD)]). Polytomous logistic regression for ordinal, categorical outcomes variables (31) was then used to allow for estimation of age-adjusted ORs, with corresponding 95% confidence intervals (CIs), for falling into a higher DQI-I (or component) quartile. *P* values for interaction were estimated by including an acculturation \times education term in a model that

Figure. Components and scoring criteria for the Diet Quality Index-International. Recommended nutrient intake levels varied by age. Recommended energy intake was based on level of physical activity reported by participant. All subscores coded as continuous. Recommended intake of food groups depending on three levels of energy intake ($\leq 1,900$ kcal; $> 1,900$ to $2,500$ kcal; and $> 2,500$ kcal). Nutrients evaluated by percentage attainment of dietary recommended intakes (40-43). AI=Adequate Intake; M:S=ratio of monounsaturated to saturated fatty acid intake; P:S=ratio of polyunsaturated to saturated fatty acid intake; RDA=Recommended Dietary Allowance. Empty calorie foods are foods for which sum of nutrient densities across 15 nutrients (protein, vitamin A, thiamin, riboflavin, vitamin B-6, vitamin B-12, niacin, folate, vitamin C, vitamin E, calcium, phosphorus, iron, magnesium, and zinc) is < 1 . Nutrient density calculated as (nutrient content/recommended nutrient intake)/(energy content/recommended energy intake) (29). Data from Kim and colleagues (29).

Component	Maximum score	Scoring criteria
Variety		
Overall food group variety (meat/poultry/fish/eggs; dairy/beans; grain; fruit; vegetable)	15	15: ≥ 1 serving/day from each food group 12: Any 1 food group missing 9: Any 2 food groups missing 6: Any 3 food groups missing 3: ≥ 4 food groups missing 0: None from any food groups
Within-group variety for protein source (meat, poultry, fish, dairy, beans, eggs)	5	5: Meaningful consumption (≥ 0.5 serving/day) from ≥ 3 different sources 3: 2 different sources 1: 1 source 0: None
Maximum score	20	
Adequacy		
Vegetable group	5	5: ≥ 3 -5 servings/day 0: 0 servings/day
Fruit group	5	5: ≥ 2 -4 servings/day 0: 0 servings/day
Grain group	5	5: ≥ 6 -11 servings/day 0: 0 servings/day
Fiber	5	5: ≥ 20 -30 g/day 0: 0 g/day
Protein	5	5: $\geq 10\%$ of energy 0: 0% of energy
Iron	5	5: $\geq 100\%$ RDA 0: 0% RDA
Calcium	5	5: $\geq 100\%$ AI 0: 0% AI
Vitamin C	5	5: $\geq 100\%$ RDA 0: 0% RDA
Maximum score	40	
Moderation		
Total fat	6	6: $\leq 20\%$ of total energy 3: > 20 -30% of total energy 0: $> 30\%$ of total energy
Saturated fat	6	6: $\leq 7\%$ of total energy 3: > 7 -10% of total energy 0: $> 10\%$ of total energy
Cholesterol	6	6: ≤ 300 mg/day 3: > 300 -400 mg/day 0: > 400 mg/day
Sodium	6	6: $\leq 2,400$ mg/day 3: $> 2,400$ -3,400 mg/day 0: $> 3,400$ mg/day
Empty calorie foods	6	6: $\leq 3\%$ of total energy 3: > 3 -10% of total energy 0: $> 10\%$ of total energy
Maximum score	30	
Overall balance		
Macronutrient ratio (carbohydrate:protein:fat)	6	6: 55-65:10-15:15-25 4: 52 to < 55 or > 65 to 68:9 to < 10 or > 15 to 16:13 to < 15 or > 25 to 27 2: 50 to < 52 or > 68 to 70:8 to < 9 or > 16 to 17:12 to < 13 or > 27 to 30 0: Otherwise
Fatty acid ratio	4	4: P:S 1-1.5 and M:S 1-1.5 2: P:S 0.8 to < 1 or > 1.5 to 1.7 and M:S 0.8 to < 1 or > 1.5 to 1.7 0: Otherwise
Maximum score	10	

Table 1. Descriptive characteristics of convenience sample of Chinese women in the Philadelphia, PA, region (n=243) by level of acculturation^a

	All women (n=243)	Acculturation Score		P value ^b
		≤9 (n=140)	>9 (n=103)	
Age (y), mean (SD) ^c	53.2 (10.5)	53.9 (10.6)	52.3 (10.2)	0.22
Birthplace (%)				0.002
China/Hong Kong	80	88	70	
Southeast Asia	12	8	17	
Taiwan	8	4	14	
Length of US residence (y), ^d mean (SD)	11.7 (8.5)	9.6 (7.4)	14.5 (9.0)	<0.0001
Age at migration (y), mean (SD)	41.4 (13.1)	44.0 (12.7)	37.8 (12.8)	0.0003
Level of education (%)				<0.0001
Less than high school graduate	40	56	19	
High school graduate to less than college graduate	37	34	41	
College graduate or beyond	23	10	40	
Body mass index, ^e mean (SD)	24.1 (3.5)	24.3 (3.4)	23.9 (3.6)	0.37
Diet Quality Index-International score, ^f mean (SD)				
Overall	65.8 (8.6)	65.5 (9.0)	66.3 (8.2)	0.47
Components				
Variety	15.3 (4.2)	14.5 (4.3)	16.4 (3.7)	0.0003
Adequacy	32.9 (5.4)	32.2 (5.2)	33.8 (4.5)	0.03
Moderation	15.0 (6.4)	16.1 (6.7)	13.5 (5.6)	0.002
Overall balance	2.6 (2.2)	2.6 (2.3)	2.6 (2.2)	0.78

^aLevel of acculturation quantified based on six questions assessing adult English proficiency and level of interaction with members of mainstream society, with possible range from 6-24 (22).
^bP values comparing women with acculturation scores ≤9 vs >9, determined using Cochran-Mantel-Haenszel test statistic for categorical variables and t test for continuous variables.
^cSD=standard deviation.
^dBecause of missing values, n=239 for length of US residence, age at migration, and body mass index.
^eBody mass index is calculated as kg/m².
^fDiet Quality Index-International used to quantify overall and four specific components of diet quality: variety, adequacy, moderation, and balance (29). See Figure for detailed description of scoring criteria.

also included both acculturation and education as dichotomous variables.

RESULTS AND DISCUSSION

Mean age of the sample was 53.2 (SD=10.5) years (Table 1). Most women (80%) were born in China or Hong Kong, with the rest from Southeast Asia or Taiwan. Mean length of US residence was 11.7 (SD=8.5) years (range <1 to 45 years), and mean age at migration was 41.4 (SD=13.1) years (range 11 to 69 years). Level of acculturation was generally low (mean 9.5 [SD=2.8]; range 6-20). Educational attainment showed greater variability, with 40% having less than a high school education but 23% having at least a college degree.

In bivariate analyses, more acculturated women were more likely to have been born in Southeast Asia or Taiwan, had a longer US residence, migrated at a younger age, and were better educated compared with less acculturated women (Table 1). With respect to diet quality, more acculturated women had higher mean scores for dietary variety and adequacy and a lower mean score for dietary moderation. Balance and overall DQI-I score were not significantly different by level of acculturation. In age-adjusted logistic regression analyses (Table 2), more acculturated women were over twice as likely to have a higher dietary variety score relative to less acculturated women (OR: 2.4; 95% CI, 1.5 to 3.8) (Table 2). Level of

acculturation also remained significantly associated with dietary adequacy, inversely associated with moderation, and not associated with overall balance or overall DQI-I score.

Other studies of Chinese Americans examined various indicators of acculturation in relation to other dietary measures. Among Chinese women in Seattle, WA, and Vancouver, Canada (14), higher Western dietary acculturation scores corresponded with increased high-fat dietary behavior, but also increased fruit and vegetable intake. A small sample of foreign-born Asian-American students reported a substantial increase in fats and sweets consumption and a decrease in vegetable consumption after immigration, but also increased dairy and fruit intake and lower meat intake (13). In a study of Chinese Americans in Pennsylvania (15), overall consumption and dietary variety increased after immigration. Length of US residence and English proficiency were associated with greater consumption of fats/sweets and meat/meat alternatives, as well as vegetables, grains, and fruits.

In their comparison of DQI-I scores between China and the United States, Kim and colleagues (29) suggested that higher variety scores in the United States were a result of greater economic prosperity and food availability. In the present sample of US Chinese women, higher variety scores among the more acculturated women may

Table 2. Age-adjusted odds ratios (95% confidence intervals) from polytomous logistic regression models for higher diet quality score in a convenience sample of Chinese women in the Philadelphia, PA, region (n=243), comparing those with higher (>9) vs lower (≤9) acculturation scores^a in all participants and stratified on level of education (less than high school graduate, high school graduate or beyond)

Diet Quality Index–International score ^b	Level of Education			P for interaction ^c
	All women (n=243)	Less than high school graduate (n=98)	High school graduate or beyond (n=145)	
Overall	1.2 (0.8-2.0)	← odds ratio (95% confidence interval) →		0.63
Components				
Variety	2.4 (1.5-3.8)	3.3 (1.3-8.3)	1.5 (0.8-2.7)	0.14
Adequacy	1.6 (1.0-2.6)	3.1 (1.2-7.7)	0.8 (0.5-1.5)	0.01
Moderation	0.6 (0.4-0.9)	0.4 (0.1-0.9)	1.1 (0.6-2.0)	0.03
Overall balance	1.0 (0.6-1.5)	0.6 (0.2-1.5)	1.3 (0.7-2.3)	0.16

^aLevel of acculturation quantified based on six questions assessing adult English proficiency and level of interaction with members of mainstream society, with possible range from 6-24 (22).
^bDiet Quality Index–International used to quantify overall and four specific components of diet quality: variety, adequacy, moderation, and balance (29). See Figure for detailed description of scoring criteria.
^cEstimated for acculturation×education interaction term in polytomous logistic regression model also including age (years), acculturation (≤9, >9), and education (less than high school graduate, high school graduate or beyond).

similarly be a result of a generally higher level of food intake in those women, possibly because greater acculturation brings new food preferences as well as greater access, opportunity, and/or resources to obtain a wider variety and greater volume of foods. These may translate into greater dietary variety and improved dietary adequacy, but less moderation.

Effects of acculturation and education are difficult to disentangle because the two factors are often correlated. Nevertheless, stratified analyses in this sample showed an effect of acculturation that persisted, at least among women with less than a high school education (Table 2). Higher level of acculturation was associated with improved dietary adequacy (OR: 3.1; 95% CI: 1.2 to 7.7) and less moderation (OR: 0.4; 95% CI: 0.1 to 0.9) only among less-educated women (P for interaction=0.01 and 0.03, respectively). A similar but nonsignificant pattern of effect modification was also evident for dietary variety, with higher level of acculturation associated with greater dietary variety only among less-educated women (OR: 3.3; 95% CI: 1.3 to 8.3). Associations were stronger still among women with <8 years of education (results not shown), but confidence intervals were wider because of the smaller sample size (n=53). That level of acculturation was not associated with variety, adequacy, or moderation scores among women with at least a high school education may suggest a maximum consumption amount such that more-educated/more-acculturated women are not eating more than (and diet quality component scores are not different from) more-educated/less-acculturated women.

Study limitations include the potential for general FFQ measurement error, use of a unidirectional acculturation measure that did not capture a bicultural state (32-34), and eligibility and exclusion criteria that may have biased results or may limit generalizability. The sample's generally low level of acculturation may also limit generalizability, although the fact that associations were apparent even with this limited range of acculturation has

its own implications, indicating that changes in diet quality can occur even early in the acculturation process.

CONCLUSIONS

The present study is among the first to examine acculturation in relation to specific components of diet quality in an immigrant group (35-38). The use of the DQI-I provides an effective means of elucidating the particular aspects of diet quality that change with acculturation and sheds light on the complexity of migration-related dietary changes in an immigrant population. Associations were not observed for overall DQI-I score, but for specific components of diet quality, namely improvements in dietary variety and adequacy of intake and a reduction in moderation, indicating that acculturation has both positive and negative effects on diet quality. The finding with respect to less moderation is consistent with the increase in incidence of many chronic conditions (1-9) and highlights the importance of acculturation-related dietary change to health risks in this immigrant population. These findings also echo a recommendation by Ayala and colleagues (39) in favor of greater specificity in dietary interventions by acculturation status; interventions among immigrant populations should be sufficiently flexible to discourage the adoption of some new dietary habits while encouraging the retention of other, traditional ones.

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