Published in final edited form as:

J Immigr Minor Health. 2015 April ; 17(2): 400–407. doi:10.1007/s10903-014-0118-4.

Acculturation and dietary change among Chinese immigrant women in the United States

Marilyn Tseng^a, David J. Wright^b, and Carolyn Y Fang^c

^aKinesiology Department, California Polytechnic State University, San Luis Obispo, CA

^bWestat, Inc., Rockville, MD

^cCancer Prevention & Control Program, Fox Chase Cancer Center, Philadelphia, PA

Abstract

Background—US Chinese immigrants undergo a transition to increased chronic disease risk commonly attributed to acculturative and dietary changes. Longitudinal data to confirm this are lacking.

Methods—We examined acculturation and diet over time in 312 Chinese immigrant women in Philadelphia, recruited October 2005 to April 2008 and followed with interviews and dietary recalls until April 2010. Associations were modeled using generalized estimating equations to account for repeated measures over time.

Results—Increasing length of US residence was associated with a small (~1%/year) but significant increase in acculturation score ($p < 0.0001$), which in turn was significantly associated with increased energy density of the diet, percent of energy from fat, and sugar intake, and lower dietary moderation score.

Discussion—These findings provide longitudinal evidence that acculturation increases with length of US residence and is accompanied by dietary changes. However, the changes were small enough that their health impact is unclear. Factors besides acculturation that affect immigrant health and that affect the acculturation trajectory itself warrant investigation.

Keywords

Acculturation; Chinese; diet; immigrants; longitudinal

INTRODUCTION

Chinese immigrants to the US undergo a transition to increased risk of weight gain (1) and chronic diseases including hypertension, diabetes, heart disease, and cancers of the colon, breast, and prostate (2–7). The health transition is commonly attributed to acculturation-related lifestyle changes, most notably to a shift towards a more “westernized” diet. In a sample of Asia-born Chinese American college students in Florida (8), 59% reported that

To whom correspondence should be addressed: Marilyn Tseng, Kinesiology Department, California Polytechnic State University, 1 Grand Avenue, San Luis Obispo, CA 93407, tel 805-756-2196/fax 805-756-7273/ mtseng@calpoly.edu.

their eating habits had changed since arrival in the US, and the proportion reporting a change increased with length of stay, from 38% among residents of <1 year to 85% among residents of at least 3 years. Reported changes included the adoption of American-style meals (pizza, burgers, sandwiches) when dining out; increased consumption of snack items; and increased frequency of consumption of fats, sweets, and dairy products.

Such changes affect diet quality. In a sample of Chinese immigrants in Pennsylvania, 57% reported that their eating habits had changed since immigration, with reported increases in consumption frequency not only of fats and sweets but also of grains, dairy products, fruits, and vegetables (9). Another study of Chinese immigrant women in Seattle also found higher fat dietary behaviors as well as greater fruit and vegetable intake after immigration (10). Finally, in a study of Chinese immigrant women in Philadelphia, level of acculturation was associated with lower dietary moderation, as indicated by intake of total and saturated fats, cholesterol, sodium, and empty calorie foods (11); the moderation component of overall dietary quality was of particular interest because of its relevance to chronic disease risk (12). Further, the association differed depending on participants' level of education, with a more pronounced association between acculturation and dietary moderation among less educated immigrants (11).

Most studies in Chinese immigrants are cross-sectional, however, and changes in dietary intake are often inferred by observing differences across groups defined by birthplace, age at migration, or length of residence (8–10, 13, 14). Such studies cannot distinguish whether these observed differences represent steps along a continuum in the same acculturative process, or the preferences of different cohorts of individuals. A longitudinal assessment would provide a more accurate picture of the process of acculturation – the extent to which the migrating generation acculturates, for example – and a better understanding of whether such change is correlated with dietary change as predicted.

A longitudinal study was conducted to examine associations among acculturation, diet, and breast cancer risk in a sample of Chinese immigrant women. The present analysis utilized data from that study to test the hypotheses that (1) acculturation and dietary intake change over time among Chinese immigrants, and (2) changes in level of acculturation, measured using a scale representing multiple dimensions of acculturation, are associated with changes in dietary factors reflecting change towards a western diet. Given results of the previous study (11), additional analyses examined whether acculturation associations varied by level of education.

METHODS

Participants

Between October 2005 and April 2008, 436 healthy, premenopausal women were recruited into a study of acculturation, diet, and mammographic breast density. Recruitment took place through local contacts, word of mouth, and community cultural and women's organizations throughout the Philadelphia region, including its major ethnic neighborhoods (Chinatown, South Philadelphia, and parts of Northeast Philadelphia), but also extending across a variety of social and economic environments in Philadelphia and its adjacent towns.

As part of the informed consent process, research staff explained the two objectives of the study: (1) to describe changes in eating habits in Chinese women in the U.S., and (2) to examine how and why breast density changes over time. They further explained that examining changes in diet and breast density might lead to a better understanding of why breast cancer risk rises in Chinese women when they come to the US.

As part of their participation in the study, women were offered free annual mammograms. Eligibility criteria included Chinese heritage, migration from Asia 20 years ago, and being of mammography screening age (≥ 35 years). Exclusion criteria were: postmenopausal status (no menstruation in the past year); history of breast augmentation/reduction, prophylactic mastectomy, or any cancer except non-melanoma skin cancer; current pregnancy; current breastfeeding or breastfeeding within last 9 months; or symptoms of new breast problem, such as palpable lump, skin changes, or nipple discharge.

Participants were contacted first by mail then by phone each year to schedule follow-up of mammographic and other measures. Follow-up ended in April 2010. Participants received \$20 as reimbursement for their time at each data collection visit. The study was approved by the Fox Chase Cancer Center Institutional Review Board, and all participants gave their written, informed consent to participate. All contact materials, including consent forms, study information brochures, and questionnaires, were translated by the project manager into Chinese and reviewed and edited by other members of the research team.

Data collection

At each data collection visit, interviewers fluent in Chinese conducted detailed health interviews, either in person or over the telephone, in the appropriate dialect – in this sample, Mandarin, Cantonese, or Fujianese. Interviews included questions on health behaviors, health, residential, and reproductive histories, and acculturation. Interviewers additionally followed an established protocol to measure weight and standing height for each participant in duplicate, with the mean used in analyses.

Interviewers were also trained to follow a standardized protocol for conducting two 48-hour dietary recall interviews about two weeks apart, with the mean over the four days used in analysis. The protocol was based on multiple pass procedures developed for use with the Nutrition Data System for Research (NDS-R, Nutrition Coordinating Center, University of Minnesota) that were also included as part of a training workshop conducted by a staff member from the Nutrition Coordinating Center. For each participant, the interviewer conducted the first dietary recall interview in person in order to provide guidance on portion size estimation using familiar 2D and 3D models. All subsequent diet interviews were administered over the telephone. While 24-hour recalls are more typical, they also involve greater logistical difficulties in trying to reach participants for interviews on multiple days. Thus, 48-hour recalls were used instead in order to capture intra-individual variability in dietary intake. Interviewers entered responses into the NDS-R, which in addition to providing estimates of nutrient intake, assigns each food item to one of 166 possible food subgroups and estimates serving counts for each food subgroup. Food subgroup definitions and serving sizes were based primarily on recommendations from the 2005 Dietary Guidelines for Americans (15) and the Food Guide Pyramid (16).

Measures

Acculturation was measured using an abridged version of the General Ethnicity Questionnaire - American version (GEQA) (17). The GEQA was chosen because of its demonstrated validity as a measure of cultural orientation among Chinese immigrants in the US and because it also allowed for assessment of acculturation as either a uni- or bi-dimensional process (17, 18). Items in the scale were translated into Chinese, then back-translated into English. Translations and back-translations were discussed by the research team, and Chinese translations were revised as necessary, then pilot-tested by a sample of middle-aged Chinese immigrant women.

The original, 37-item GEQA scale, developed for immigrant and American-born Chinese college students, showed good validity and reliability in Chinese immigrants in previous studies (17, 19). Assessed in factor analysis, it encompassed six distinct factors representing English language use and proficiency; affiliation with American people; participation in American activities; pride in American culture; preference for English language media; and preference for American food (17). For the current study items were dropped if they showed little variability in response during pilot testing among a sample of middle-aged Chinese women, most of whom migrated as adults (e.g., 'I was raised in a way that was American', 'How much do you speak English at school?'). The remaining eleven items dealt with exposure to or familiarity with American people, culture, and activities (Table 1). Responses were graded on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), except for one question on English language use that was graded from 1 (not at all) to 5 (very much). The average response to these eleven items was the GEQA score, with a minimum of 1.0 (least acculturated) and a possible maximum score of 5.0 (most acculturated). In an *ad hoc* evaluation of construct validity (20), the abridged scale was significantly (all $p < 0.01$) correlated with length of residence (Pearson's $r = 0.17$), age at migration ($r = -0.14$), and a separate, global indicator of American cultural orientation ('Overall I am American') ($r = 0.27$). The scale also showed high internal reliability in the study sample (Cronbach's $\alpha = 0.91$).

The Diet Quality Index-International (12) was used to examine one specific component of diet quality – dietary moderation, specifically with respect to five factors (total fat, saturated fat, cholesterol, sodium, and empty calorie foods) whose intake should be restricted because of their associations with chronic disease development. Details on the components of the dietary moderation subscale, with possible scores ranging from 0–30, are given in Table 2. Other dietary outcome variables of interest were selected for their relevance to the moderation component of diet quality. These included energy density, percent of energy from fat, and intake of total energy and sugar. Specific food groups selected for analysis in relation to acculturation were: all vegetables, dark-green vegetables, tofu, fruits, beef, pork, fish, grains cooked from dry (e.g., rice), breads, pastries, and dairy foods.

At baseline, participants were asked about their highest level of education, and responses were collapsed into three categories: (1) 0–8 years, (2) 9–12 years, with or without completion of high school or vocational/technical school, and (3) at least some college, university, or graduate school. For residential histories, participants listed every place where

they lived for at least one year and their age when they moved there; from these, length of US residence and age at migration were calculated.

Analysis

Of 436 women enrolled in the study, seven were excluded for not having completed baseline questionnaires (n=3), any dietary interviews (n=3), or the question on country of birth, an adjustment variable in multivariate regression analyses (n=1), leaving a sample of 429.

Regressions were run using generalized estimating equations (GEE), taking into account repeated measures from 1,126 visits among 429 participants. Of these, 312 participants provided follow-up dietary interviews for longitudinal analyses, while 117 provided only a baseline dietary interview. Participants with and without follow-up data were compared using chi-square test statistics for categorical variables and t-tests for continuous variables.

Initial analyses were conducted to describe changes over time in GEQA and dietary variables, in addition to weight and body mass index (BMI). These were first modeled in GEE as a function only of length of US residence. Length of US residence rather than age or time in study was included as a time-varying, continuous predictor variable because it was thought to be more conceptually meaningful, especially given the common assumption that length of US residence can be used as a proxy for acculturation.

Next, associations between acculturation and diet were examined by modeling each dietary variable as a function of GEQA (included as a time-varying, continuous variable) and covariates. Covariates included age at baseline (years), country of birth (China or elsewhere), marital status (married or not), and education (0–8 years, 9–12 years (with or without completion of high school or vocational/technical school), and at least some college, university, or graduate school). Length of residence was not included as a covariate so as to avoid confounding with the GEQA effect.

To examine possible differences by level of education (11), effect modification was examined in models by including an interaction term. The GEQA model was enhanced by including a length of residence (continuous years) x education category (nominally coded) interaction. The dietary models were enhanced by including a GEQA (continuous score) x education category (nominally coded) interaction. All statistical analyses were conducted using SAS (version 9.2, 2008, SAS Institute, Cary, NC).

RESULTS

Description of sample

Mean (SD) age of the sample at baseline was 43.9 (4.5) years (Table 3). Most were born in China (97%). Mean (SD) age at migration to the US was 36.4 (6.5) years, and mean (SD) length of US residence was 7.5 (4.8) years. Mean (SD) GEQA score in this sample was 2.1 (0.7), and 70% reported speaking no English at home. Mean (SD) weight and BMI were 58.4 (7.8) kg and 23.4 (2.8) kg/m², respectively. Among the 312 (73%) of participants who provided dietary interviews on at least two visits (baseline and at least one follow-up), 113 provided data on three occasions, and 136 provided data on four. In total, the 312

participants provided 1,009 observations over a mean (SD) length of follow-up of 2.7 (0.9) years. Compared with the 312 participants with follow-up data, the 117 women who provided only a baseline dietary interview were better educated, migrated at a later age, and had shorter length of residence in the US (Table 3). The two groups did not differ with respect to age, mean acculturation score, or other characteristics measured at baseline.

Changes in acculturation and dietary intake over time

Table 4 describes the changes in GEQA score and dietary intake with increasing length of US residence in our sample, measured longitudinally. Among 312 participants with follow-up data, increasing length of residence in the US was accompanied by a small but significant increase in level of acculturation as indicated by GEQA score (Table 4). The increase was apparent primarily in more educated women (Figure 1), among whom GEQA increased by 0.04 point per year, compared with 0.01 point per year in the least educated category of women (interaction p-value=0.02). Separate analyses were conducted among women with shorter (<4 y), mid-range (4–10 y), and longer (10+ y) US residence to determine whether level of acculturation changes more rapidly for recent immigrants but saw no evidence of a differential rate of change by length of residence (results not shown). Longer US residence was also associated with an increase in energy density of the diet and a decrease in total gram intake of food (Table 4). It was also associated with an increase in BMI but not significantly with an increase in weight. Intake of energy and sugar, percent of energy from fat, and dietary moderation did not change significantly with increasing length of residence.

Acculturation as a predictor of dietary intake

Next, acculturation was evaluated as a predictor of dietary change. In GEE models, an increase in GEQA score over time was significantly associated with an increase in energy density of the diet, higher percent of energy from fat, and greater sugar intake, and with a decrease in dietary moderation and in total gram intake of food (Table 5).

In additional analyses to assess possible GEQA effect modification by level of education, p-values for interaction were statistically significant for total energy intake and percent of energy from fat ($p=0.01$). Specifically, greater acculturation was associated with an increase in energy intake and percent of energy from fat only in less educated women. In women with at least some college education, in contrast, there was little change in percent of energy from fat and a slight decrease in total energy intake with increasing level of acculturation. Figure 2 illustrates the difference in predicted mean energy intake and percent of energy from fat between participants with GEQA scores of 1 and 2, separated by level of education.

In an exploration of food groups of a priori interest, an increase in GEQA score over time was significantly associated with increased intake of beef, pork, dairy, and breads, and with decreased intake of dark green vegetables and grains cooked from dry (Table 5). GEQA change over time was not significantly associated with change in intake of fish, pastries, total vegetables, tofu, or fruits.

DISCUSSION

The present study is the first to document in a prospective cohort that change in acculturation over time is associated with change towards a less moderate diet, which could contribute to the observed increased risk of various chronic diseases following migration. The findings also demonstrate that change in acculturation, as measured by GEQA, over time was associated with change towards a less moderate diet – higher energy density, higher percent of energy from fat, and greater sugar intake. In terms of food intake, greater acculturation was associated with an increase in intake of red meats, dairy, and breads, and a decrease in intake of dark green vegetables and grains cooked from dry, such as rice.

A common assumption is that acculturation and, accordingly, diet change with length of US residence after immigration. While our findings support this, it should be noted that the changes in acculturation and diet in our sample, while statistically significant, were relatively small. Although length of US residence is commonly used as a proxy for level of acculturation (21), the increase in acculturation over time in this sample amounted to only a 0.024 point increase in GEQA score for each additional year in the US, or the equivalent of 1% of the mean GEQA score in our sample. Assuming a linear increase in acculturation, 20 years in the US would produce a 0.5 point increase on this acculturation scale. Thus, at least in some immigrant populations, increasing length of residence in the US might bring about little change in acculturation. Many of the participants in the current sample resided in immigrant or ethnic enclaves throughout Philadelphia – about 12% in Chinatown, 25% in South Philadelphia, and 34% in neighborhoods in Northeast Philadelphia. To the extent that residence in an immigrant enclave limits exposure to mainstream culture, there may be less opportunity or need for acculturation to the mainstream, and these residents are thus more likely to preserve traditional behaviors (22). These findings suggest the need for caution in using length of residence as a proxy for level of acculturation, and may explain why, in this sample, length of US residence was a poorer predictor of change in dietary behavior than was acculturation score.

The dietary changes associated with acculturation were also relatively small. Each one-point increment in GEQA score, with a possible range from 1 to 5, was associated with an 8% increase in energy density, a 1.3% absolute increase in percent of energy from fat, a 2.8 g/day increase in sugar intake, and a 3% decrease on the dietary moderation scale. Given the small change in GEQA with length of US residence overall, at least in this sample of Chinese women, change in diet with acculturation might not be as great as has been supposed previously based on cross-sectional data. Acculturative and dietary changes may be greater among immigrants who arrive as children or young adults (23), or who do not reside in ethnic enclaves, but this requires confirmation in other, longitudinal work.

A previous, cross-sectional study in another sample of Chinese immigrant women suggested a difference in effect of acculturation by level of education (11). In that study, acculturation was associated with lower dietary moderation among Chinese immigrant women with less than a high school education, but not among women who were at least high school graduates. In the present, prospective analysis, the changes in energy density, sugar intake, and dietary moderation with acculturation were independent of level of education. However,

a similar pattern of effect modification for energy intake and percent energy from fat was apparent, with changes with acculturation more evident in less educated women. An increase in these with acculturation is not surprising in less educated women, who reported very low energy intake and percent of energy from fat to begin with. Why the values appear to plateau in more educated women is less clear. Energy density and sugar intake still increased with acculturation in these women, and dietary moderation decreased. Further, their percent of energy from fat was still lower than the estimated 33% for the US adult population (24). Whether these plateaus are maintained in this generation remains to be explored with additional follow-up of the cohort.

A primary limitation of the study was the use of 48-hour recalls. Standard, multiple-pass procedures were used to minimize misreporting. Also, additional analyses comparing the distributions of several nutrient variables based on days 2 and 4 of the four dietary recall days (the equivalent of two regular 24-hour recalls) with distributions based on all four days from the two 48-hour recalls showed comparable means, and the expected increase in variance in distributions based on only two rather than four days of recalls. Nevertheless, underestimation of intake is likely, as evidenced by the low estimates of mean energy intake in the sample. With the availability of repeat, longitudinal observations, differential reporting across participants is less a concern than dietary measurement error, which likely resulted in underestimation of the magnitude of associations investigated here. New technologies such as wearable cameras (25, 26) or mobile telephone-based technologies (27) may help reduce the problem of underreporting as a result of missing foods or underestimating portion sizes. Such emerging technologies and methods will be useful if they can be applied to measure dietary changes among immigrants more accurately.

Generalizability of the results may also be limited. This was a convenience sample of women who were offered free annual mammograms as part of the study, and may also have been motivated by a sense of concern over breast cancer risk. Thus, compared with the overall Chinese immigrant community in Philadelphia, this sample was likely to be less acculturated, uninsured, and of lower socioeconomic background. Further, women with higher levels of education and shorter US residence were more likely to have provided only baseline data and were thus underrepresented in the follow-up. Finally, the relatively short follow-up limited the extent of change in acculturation observable in this sample. Worth noting, however, is that although the change in acculturation observed over time was small, it was statistically significant. Differences in acculturation by length of residence might be overstated in cross-sectional studies if different immigrant cohorts are being compared, rather than measuring actual changes over time.

Nevertheless, the fact that significant changes in acculturation were observed, as well as associations between acculturative and dietary change over time, is an important confirmation of assumptions made in prior, cross-sectional studies. These analyses also revealed differences in the magnitude of change in GEQA and in the association between GEQA and dietary intake by level of education, indicating differences in trajectory across subsets of immigrants.

CONCLUSIONS

As the first prospective study with detailed information collected on acculturation and dietary behaviors, our findings highlight several directions for further research. For example, future studies should confirm these trajectories in other immigrant samples, using valid and precise measures of dietary intake; identify the key factors, whether environmental circumstances or personal characteristics, that influence this acculturative trajectory; describe other trajectories possible under different conditions; and investigate how these acculturation trajectories might influence lifestyle changes and health behaviors that can impact disease risk.

In summary, in our sample of Chinese women who had immigrated to the US as adults, we found that increasing length of US residence was associated with a significant but small increase in level of acculturation. Increasing level of acculturation, in turn, was associated with change in dietary intake towards higher energy density, higher percent of energy from fat, greater sugar intake, and less dietary moderation overall – but it should be highlighted that the changes associated with acculturation were small. These findings suggest useful directions for future work – specifically, exploring the magnitude of change in acculturation and diet longitudinally in other immigrant samples, and identifying other factors besides acculturation that might influence health trajectories in the migrating generation.

Acknowledgments

This work was supported by grants R01 CA106606 and P30 CA006927 from the National Institutes of Health. The authors are indebted to Ms. Wanzi Yang, Ms. Qi He, Ms. Rong Cheng, Ms. Bingqin Zheng, Dr. Zemin Liu, and Ms. Yun Song for their crucial work in the collection and management of data for this study. The authors also thank Dr. Yu-Wen Ying for her assistance with the General Ethnicity Questionnaire; Mr. Andrew Balshem, Joseph Bland, and the Fox Chase Cancer Center Population Studies Facility for their data management support; and Dr. Philip Siu and Dr. Thomas Yuen of Chinatown Medical Services for their generous assistance in participant recruitment.

References

1. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. *JAMA*. 2004; 292:2860–7. [PubMed: 15598917]
2. Ziegler RG, Hoover RN, Pike MC, Hildesheim A, Nomura AM, West DW, et al. Migration patterns and breast cancer risk in Asian-American women. *J Natl Cancer Inst*. 1993; 85:1819–27. [PubMed: 8230262]
3. Stanford JL, Herrinton LJ, Schwartz SM, Weiss NS. Breast cancer incidence in Asian migrants to the United States and their descendants. *Epidemiology*. 1995; 6:181–3. [PubMed: 7742407]
4. Cook LS, Goldoft M, Schwartz SM, Weiss NS. Incidence of adenocarcinoma of the prostate in Asian immigrants to the United States and their descendants. *J Urol*. 1999; 161:152–5. [PubMed: 10037388]
5. Huh J, Prause JA, Dooley CD. The impact of nativity on chronic diseases, self-rated health and comorbidity status of Asian and Hispanic immigrants. *J Immigr Minor Health*. 2008; 10:103–18. [PubMed: 17546500]
6. Rajpathak SN, Wylie-Rosett J. High prevalence of diabetes and impaired fasting glucose among Chinese immigrants in New York City. *J Immigr Minor Health*. 2011; 13:181–3. [PubMed: 20533090]
7. Chiu M, Austin PC, Manuel DG, Tu JV. Cardiovascular risk factor profiles of recent immigrants vs long-term residents of Ontario: a multi-ethnic study. *Can J Cardiol*. 2012; 28:20–6. [PubMed: 21827964]

8. Pan Y, Dixon Z, Himburg S, Huffman F. Asian students change their eating patterns after living in the United States. *J Am Diet Assoc.* 1999; 99:54–7. [PubMed: 9917732]
9. Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *J Am Diet Assoc.* 2004; 104:771–8. [PubMed: 15127063]
10. Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *J Am Diet Assoc.* 2001; 101:548–53. [PubMed: 11374348]
11. Liu A, Berhane Z, Tseng M. Improved dietary variety and adequacy but lower dietary moderation with acculturation in Chinese women in the United States. *J Am Diet Assoc.* 2010; 110:457–62. [PubMed: 20184998]
12. Kim S, Haines PS, Siega-Riz AM, Popkin BM. The Diet Quality Index-International (DQI-I) provides an effective tool for cross-national comparison of diet quality as illustrated by China and the United States. *J Nutr.* 2003; 133:3476–84. [PubMed: 14608061]
13. Rosenmoller DL, Gasevic D, Seidell J, Lear SA. Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. *Int J Behav Nutr Phys Act.* 2011; 8:42. [PubMed: 21592378]
14. Wong SS, Dixon LB, Gilbride JA, Kwan TW, Stein RA. Measures of acculturation are associated with cardiovascular disease risk factors, dietary intakes, and physical activity in older Chinese Americans in New York City. *J Immigr Minor Health.* 2013; 15:560–8. [PubMed: 22752686]
15. US Department of Health and Human Services, US Department of Agriculture. Dietary Guidelines for Americans, 2005. 6. Washington, DC: US Government Printing Office; 2005.
16. US Department of Agriculture. MyPyramid.gov. 2005. Dec 8. 2009 Available from: <http://www.mypyramid.gov/index.html>
17. Tsai JL, Ying Y, Lee P. The meaning of “Being Chinese” and “Being American”: Variation among Chinese American young adults. *Journal of Cross-cultural Psychology.* 2000; 31:302–32.
18. Ying Y-W, Han M, Tseng M. Acculturation and post-migration stress in middle-aged Chinese immigrant women in Philadelphia: Variation between the Fujianese and the non-Fujianese women. *Journal of Human Behavior in the Social Environment.* 2012; 22:20–38. [PubMed: 22451743]
19. Ying Y. Migration and cultural orientation: An empirical test of the psychoanalytic theory in Chinese Americans. *Journal of Applied Psychoanalytic Studies.* 2001; 3:409–30.
20. Tseng M, Fang CY. Stress is associated with unfavorable patterns of dietary intake among female Chinese immigrants. *Ann Behav Med.* 2011; 41:324–32. [PubMed: 21384248]
21. Salant T, Lauderdale DS. Measuring culture: a critical review of acculturation and health in Asian immigrant populations. *Soc Sci Med.* 2003; 57:71–90. [PubMed: 12753817]
22. Miller AM, Birman D, Zenk S, Wang E, Sorokin O, Connor J. Neighborhood Immigrant Concentration, Acculturation, and Cultural Alienation in Former Soviet Immigrant Women. *J Community Psychol.* 2009; 37:88–105. [PubMed: 21127738]
23. Cheung BY, Chudek M, Heine SJ. Evidence for a sensitive period for acculturation: younger immigrants report acculturating at a faster rate. *Psychol Sci.* 2011; 22:147–52. [PubMed: 21189354]
24. Wright JD, Wang CY. Trends in intake of energy and macronutrients in adults from 1999–2000 through 2007–2008. *NCHS Data Brief.* 2010:1–8.
25. Gemming L, Doherty A, Kelly P, Utter J, Ni Mhurchu C. Feasibility of a SenseCam-assisted 24-h recall to reduce under-reporting of energy intake. *European journal of clinical nutrition.* 2013; 67:1095–9. [PubMed: 24002044]
26. Jia W, Chen HC, Yue Y, Li Z, Fernstrom J, Bai Y, et al. Accuracy of food portion size estimation from digital pictures acquired by a chest-worn camera. *Public Health Nutr.* 2014; 17:1671–81. [PubMed: 24476848]
27. Illner AK, Freisling H, Boeing H, Huybrechts I, Crispim SP, Slimani N. Review and evaluation of innovative technologies for measuring diet in nutritional epidemiology. *Int J Epidemiol.* 2012; 41:1187–203. [PubMed: 22933652]

Figure 1. Predicted GEQA score by length of residence, in model including length of residence, level of education, and length of residence * education category interaction term.

Figure 2.

Predicted (a) energy intake and (b) percent of energy from fat assuming GEQA=1 or 2 by level of education, for a reference study participant age 40–49 years old, married, and born in China. Model included age, level of education, marital status, birthplace, GEQA, and GEQA * education category interaction term.

Table 1

Items included in abridged General Ethnicity Questionnaire – American version, used to assess level of acculturation.

1	Now, I am exposed to American culture.
2	I go to places where people are American.
3	I am familiar with American cultural practices and customs.
4	I admire people who are American.
5	I listen to American music.
6	I engage in American forms of recreation.
7	I celebrate American holidays.
8	At home, I eat American food.
9	At restaurants, I eat American food.
10	Now, my friends are American.
11	How much do you speak English at home?

Table 2

Scoring criteria for the dietary moderation component of the Diet Quality Index – International (DQI-I)^a, adapted from Kim et al. (12)

Moderation	Scoring criteria
Total fat	6: 20% of total energy 3: >20–30% of total energy 0: >30% of total energy
Saturated fat	6: 7% of total energy 3: >7–10% of total energy 0: >10% of total energy
Cholesterol	6: 300 mg/day 3: >300–400 mg/day 0: >400 mg/day
Sodium	6: 2400 mg/day 3: >2400–3400 mg/day 0: >3400 mg/day
Empty calorie foods ^a	6: 3% of total energy 3: >3–10% of total energy 0: >10% of total energy

^a Defined as 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). Recommended nutrient intake levels varied by age. Recommended energy intake was based on level of physical activity reported by participant.

Table 3

Descriptive characteristics of a sample of US Chinese immigrant women.

	All participants (N=429)	Followed (N=312)	Not followed (N=117)
Age (years)			
Mean (SD)	43.9 (4.5)	43.8 (4.5)	44.1 (4.5)
Range	35–56	35–56	35–56
Born in China (%)	97	98	95
Level of education (%)			
0–8 years	48	53	37
9–12 years	35	33	39
at least some college	17	14	24**
Employed (%)	91	92	87
Married (%)	93	94	91
Age at migration (y)			
Mean (SD)	36.4 (6.5)	35.9 (6.3)	37.6 (6.8)*
Range	16–54	16–54	23–52
Length of US residence (y)			
Mean (SD)	7.5 (4.8)	7.9 (4.7)	6.5 (4.8)**
Range	<1–20.8	<1–20.8	<1–18.5
Score on General Ethnicity			
Questionnaire – American version			
Mean (SD)	2.1 (0.7)	2.1 (0.7)	2.2 (0.8)
Range	1.0–4.1	1.0–4.1	1.0–3.8
Speak no English at home (%)	70	71	65
Weight (kg)			
Mean (SD)	58.4 (7.8)	58.6 (7.8)	57.7 (7.7)
Range	40.6–82.3	40.6–78.8	43.3–82.3
Body mass index (kg/m ²)			
Mean (SD)	23.4 (2.8)	23.5 (2.8)	23.3 (2.9)
Range	17.2–33.2	17.2–33.2	17.2–30.7
Mean (SD) intake per day			
Energy (kcal)	1361 (367)	1364 (375)	1353 (347)
Total food intake (g)	1798 (565)	1818 (560)	1742 (577)
Energy density (kcal/g)	0.80 (0.24)	0.80 (0.25)	0.83 (0.23)
Total fat (% kcal)	24.4 (6.1)	24.2 (6.0)	25.2 (6.3)
Total sugar (g)	40.1 (22.8)	40.7 (23.2)	38.6 (21.7)
Dietary moderation	22.5 (5.2)	22.7 (5.2)	22.0 (5.1)
Number of visits (%)			
1	27	-	100
2	14	19	-
3	27	37	-
4	32	44	-

*
p<0.05 comparing participants with and without follow-up data

**
p<0.01 comparing participants with and without follow-up data

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 4

Change in score on General Ethnicity Questionnaire – American version (GEQA) and selected dietary variables per year of US residence (n=312).

	Beta^a (SE)	p-value
GEQA	0.024 (0.006)	<0.0001
Energy (kcal)	2.8 (2.6)	0.27
Total food intake (g)	-10.1 (3.3)	0.002
Energy density (kcal/g)	0.0066 (0.0015)	<0.0001
Total fat (%)	0.005 (0.041)	0.90
Total sugar (g)	-0.13 (0.17)	0.44
Dietary moderation	0.04 (0.38)	0.30
Weight (kg)	0.08 (0.04)	0.09
Body mass index (kg/m ²)	0.04 (0.02)	0.009

^a Modeled using generalized estimating equations with length of US residence as only predictor variable for different outcomes of interest.

Table 5

Adjusted ^a change in dietary variables per 1-unit increment in score on General Ethnicity Questionnaire – American version (n=312).

	Beta (SE)	p-value
Energy (kcal)	31.4 (18.0)	0.08
Total food intake (g)	−102.4 (24.5)	<0.0001
Energy density (kcal/g)	0.06 (0.01)	<0.0001
Total fat (%)	1.3 (0.3)	<0.0001
Total sugar (g)	2.8 (1.1)	0.01
Dietary moderation	−0.71 (0.24)	0.003
Foods (servings/day)		
Beef	0.100 (0.029)	0.0007
Pork	0.193 (0.063)	0.002
Fish	−0.174 (0.130)	0.18
Dairy	0.064 (0.030)	0.04
Flour/rice	−0.243 (0.119)	0.04
Bread	0.122 (0.045)	0.007
Pastries	−0.007 (0.013)	0.62
All vegetables	0.051 (0.076)	0.50
Dark green vegetables	−0.094 (0.045)	0.04
Tofu	−0.141 (0.078)	0.07
Fruit	0.009 (0.096)	0.92

^a Modeled using generalized estimating equations, with adjustment for age, education, marital status, and country of birth.