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Stress Is Associated with Unfavorable Patterns of Dietary Intake among Female Chinese Immigrants

Marilyn Tseng, PhD and
California Polytechnic State University, San Luis Obispo

Carolyn Y. Fang, PhD
Fox Chase Cancer Center

Abstract

Background—Chinese immigrants experience increased risk for weight gain and chronic disease after US migration. Whether psychosocial stress affects their eating behavior is unknown.

Purpose—To examine psychosocial stress and dietary intake among 426 Chinese immigrant women in the Philadelphia region.

Methods—Participants completed 4 days of dietary recalls and questionnaires assessing positive and negative life events in the past year and migration-related stressors.

Results—In hierarchical linear regression models, positive life events were associated with higher energy intake (β=21.1, p=0.04). Migration-related stress was associated with lower total gram (β=−11.3, p<0.0001) and grain (β=−0.18, p=0.03) intake overall, and higher energy density (β=0.002, p=0.04) and % energy from fat (β=0.06, p=0.05).

Conclusions—Migration-related stress did not increase overall intake in terms of energy and total grams, but selectively increased fat intake and energy density. Such dietary habits may have implications for future chronic disease risk in this immigrant population.

Keywords

stress; Asian; dietary intake; acculturation

Introduction

In the United States (US), approximately 33% of adults are reported as being obese (1). Although obesity is less common in Asian countries such as China and Japan, Asian-born Americans report weight gain after migration to the US (2). Post-migration weight gain may be due not only to changes in physical activity and an increased sedentary lifestyle, but also to changes in eating habits, such as the adoption of American-style meals (pizza, burgers, sandwiches), increased consumption of snacks, fats, and sweets (3–5), and an overall decrease in diet quality that may contribute to increased risk for chronic disease (6–10).

Many external factors likely influence dietary patterns after migration to another country, including the environmental availability of various foods. Acculturation, the process by which individuals in a minority group adopt the lifestyle characteristics of the mainstream culture (11), also contributes to dietary changes. Indeed, a number of studies have reported

Corresponding author: Marilyn Tseng, Ph.D., Department of Kinesiology, California Polytechnic State University, San Luis Obispo, CA 93405, mtseng@calpoly.edu.

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that greater acculturation among Asian immigrants was associated with a shift towards a more “westernized” diet and unhealthy dietary changes, such as increased consumption of fats and sweets (5).

Weight gain among immigrants to the US has been primarily attributed to changes in eating habits due to acculturation and the increased availability of different foods, but surprisingly little attention has focused on the role of migration-related acculturative stress. The process of acculturation not only involves adopting new lifestyle characteristics, but it can also lead to significant cultural and social disequilibration and is, thus, likely to engender psychological distress (12). This has been empirically demonstrated in Chinese immigrants (13) across a number of studies that have documented how migration-acculturation stressors diminish health and well-being (12,14–16). Stress, in turn, has been demonstrated to lead to alterations in eating patterns (17–21) and to contribute to weight gain (22).

The relationship between stress and eating patterns is complex, but a number of animal and human studies suggest that stress is associated with unhealthy changes in eating behaviors, such as increased fat intake (17,23,24) and higher consumption of snack-type foods (25,26). Large-scale human studies have reported associations of perceived stress with a higher-fat diet (17), increased consumption of high fat and high sugar snack foods, and a reduction in vegetable intake (19). Data from animal studies have been mixed, with the association between stress and eating behaviors varying according to the severity of the stressor and the type of food available (27). However, it has been consistently observed that mild to moderate stressors are associated with increased intake of highly palatable foods (e.g., sweetened condensed milk (28,29)). Rats exposed to chronic stress (i.e. restraint stress) had reduced caloric intake compared with non-restrained controls, but they had increased intake of comfort foods (i.e. lard and sucrose, or highly palatable, high energy foods) (30). Similarly, stress-induced mice selected more calories from fat than non-stressed mice, when given free access to high fat and high carbohydrate diets (27). A review of studies concluded that higher stress is generally associated with an increased preference for energy-dense foods in humans as well (21).

The stress-dietary intake relationship also appears to hold true in diverse populations, such as among women or ethnic/racial minority populations (31). For example, naturalistic studies have reported that interpersonal and work-related stress were associated with increased intake of high fat and sugary snacks (19), and that this association was most notable among women. Among African American men and women, perceived stress was associated with unhealthy eating behaviors including emotional eating and haphazard planning of meals (20). Further, gender differences emerged, with African American females reporting not only greater perceived stress than African American males, but also more frequent snacking on sweets (20).

Given that migration to the US can be a significant stressor, and in light of empirical data suggesting an association between stress and eating behaviors, we examined whether life event stress in general, and migration-related stress specifically, are associated with unhealthier eating habits (i.e. higher % fat intake, higher energy density, fewer vegetables and grains) among foreign-born Chinese women. In addition, given that acculturation is associated with unhealthy dietary changes, it was proposed that these associations would differ by level of acculturation, with more acculturated women showing stronger associations between stress and dietary intake. To our knowledge, no previous studies have examined the impact of migration-related stress on dietary behaviors in US immigrants.

Methods

Participants

Between October 1, 2005, and April 30, 2008, we recruited 436 healthy, premenopausal women from community organizations and contacts into a study of diet and mammographic breast density. Eligibility criteria included Chinese heritage, migration from Asia ≤20 years ago, and being of mammography screening age. 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 received $20 as reimbursement for their time. The study was approved by the Fox Chase Cancer Center Institutional Review Board, and all participants gave their written informed consent to participate in the research.

Measures

Interviewers who were fluent in Chinese administered detailed health interviews in the appropriate dialect (Mandarin, Cantonese, or Fujianese). Interviews elicited information on various health behaviors, health and reproductive history, and sociodemographic characteristics. To assess the presence and severity of various migration-related stressors, we used the Migration-Acculturation Stressor Scale (32), which has good psychometric properties in ethnic Chinese international students in the US. The scale is comprised of 22 potential acculturative stressors, including cultural, social, and functional difficulties – for example, difficulties with language (functional), missing their family (social), or being in an unfamiliar environment (cultural). For each item, participants were asked if they had encountered that difficulty in the last year, with answers ranging from 1 (no) to 5 (very much). Total level of acculturative stress was then calculated by summing across all 22 items (33). Internal reliability of this measure was high in this sample (Cronbach's $\alpha = 0.85$). In the present study, 383 women provided responses to all 22 items in the scale. No participant had more than four missing items on the scale. For women missing one to four items, we used the sample mean for the missing item in computing the woman's scale score. Sensitivity analyses limited to the 383 women with complete data on all 22 items showed no meaningful differences in findings compared to those based on all women.

To assess non-migration-specific life events that may affect the study participants, we used a modified version of the Life Experiences Survey (34) that was developed for use with an ethnically and socioeconomically diverse population residing in an urban environment (35). The original Life Experiences Survey is a commonly utilized, 57-item instrument that assesses both positive and negative life experiences and the individual's perception of the impact of each event, and it has been shown to have good reliability and validity (34). The modified instrument used in the present study omitted items specific to males and to college students, for whom the instrument was originally developed, and included events that may be relevant for urban, low socioeconomic dwellers, such as being a victim of a crime. Respondents rated each of the resulting 44 life events on a 7-point scale ranging from −3 (extremely negative) to +3 (extremely positive). If an event did not occur, the item was coded as 0. In prior studies, the modified instrument demonstrated good convergent validity when used in an ethnically and socioeconomically diverse sample (35).

Acculturation was measured using an abridged version of the General Ethnicity Questionnaire - American version (36). All items on the scale are scored on a five-point Likert type scale, with higher scores representing greater endorsement of American culture. The mean of all items in the scale is then used to quantify overall endorsement of American

culture. The 37-item scale was found to have good validity and reliability in Chinese immigrants in previous studies (36,37). Because the original scale was developed for immigrant and American-born Chinese college students, for the current study we dropped items that showed little if any variability in response during initial pilot testing among a sample of middle-aged Chinese women, the majority of whom migrated to the U.S. in adulthood (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 (e.g., 'Now, I am exposed to American culture,' 'I go to places where people are American,' 'I celebrate American holidays'). Internal reliability of the abridged version was high with an alpha coefficient of 0.91.

Trained interviewers followed a standardized protocol for conducting two 48-hour dietary recall interviews for each participant, within two weeks of each other, and for entering responses into the Nutrition Data System for Research (Nutrition Coordinating Center, University of Minnesota), whose database includes 160 nutrients, nutrient ratios, and other food components. Most mixed dishes were entered as their individual component foods (e.g., rice porridge with sweet potato entered separately as rice porridge and sweet potato). Foods not included in the nutrient database were added by creating recipes for new mixed dishes, or by the Nutrition Coordinating Center, which bases nutrient values on information from food manufacturers, foreign food composition tables, the scientific literature, and other available databases. In addition to providing estimates of nutrient intake, the software assigns each food item to one of 166 possible food subgroups and estimates serving counts for each food subgroup. Food items are counted at the whole food level when appropriate (e.g., bread, apple pie, French fries), or at the component/ingredient level (e.g., lasagna, soup, fruit salad, sandwiches) to capture intake of ingredients. Food subgroup definitions and serving sizes were based primarily on recommendations from the 2005 Dietary Guidelines for Americans (38) and the Food Guide Pyramid (39). Food and Drug Administration serving sizes (40) were used for foods not included among current recommendations, such as cookies and fruit drinks. Estimates of nutrient and food intake were averaged over the four days to obtain an estimate of mean intake for each participant.

Statistical analyses

Of 436 women enrolled in the study, three women subsequently did not complete baseline questionnaires, and seven were excluded for not having completed dietary interviews, leaving a sample of 426 women.

Dietary outcome variables of interest were selected a priori for their relevance to adiposity or cardiovascular outcomes, or based on findings from previous studies on psychosocial stress and diet (17,19,21,23–26). These included total gram intake, intake of energy and total sugar, energy density, and percent of energy from fat, carbohydrates, and protein. To explore differences in intake of food groups in relation to psychosocial stress, we examined grains (e.g., rice, flour, cooked cereals), pasta/noodles, breads (loaf-type and quick breads), pastries (e.g., cakes, cookies, pies, danishes), chips, beef, pork, fish, soup broths, vegetables, and fruits. Of these, only intake of grains showed a clear association with stress variables in preliminary analyses and was examined further.

We used standard procedures (34,41) to calculate scores based on events reported on the Life Experiences Survey. Briefly, positive and negative events were differentiated based on whether respondents reported a positive (1 to 3) or negative (−1 to −3) impact for the event. Events that were reported as having a positive impact were summed to create the total number of positive life events; likewise, those that were reported as having a negative impact were summed to create the total number of negative life events. Positive and negative impact rating scores were calculated by summing the impact ratings of positive and negative

events, respectively, with the absolute value of impact ratings used for negative events. Results using the number of positive and negative events were similar to results based on their respective impact rating scores; therefore, only results for impact rating scores are presented.

We used hierarchical regression analyses to examine associations of continuous life experience impact rating and migration-related stressor scores with dietary outcome variables. All stress and acculturation scores were centered prior to inclusion in models. In the regression models, four blocks of variables were entered sequentially. The blocks were comprised of: (a) potential covariates, including age (continuous years), level of education (<8 years, 9–12 years or technical school, at least some college), marital status (married, not married), and length of US residence (continuous years); (b) acculturation (continuous score); (c) all stress scores, including positive and negative life event impact scores and the migration-related stressor score; and (d) acculturation x stress interaction term to examine potential effect modification by level of acculturation. Interaction terms were computed using the centered continuous acculturation and stress variables. Separate models were used to examine interactions of acculturation with each stress variable (positive event ratings, negative event ratings, acculturative stress). Regression diagnostics indicated no problems with collinearity for the variables included in the models. Statistical analyses were conducted using SAS (version 9.1.3, 2005, SAS Institute, Cary, NC) and PASW Statistics (version 17.0, 2009, Somers, NY).

Results

Among the 426 women in the sample, mean age was 43.9 (SD = 4.5) years, with a range of 35–56 years (see Table 1). The women had lived in the US for a mean of 7.5 (SD = 4.8) years and migrated to the US at a mean age of 36.4 (SD = 6.5) years. Almost all (97%) were born in China, and most (69%) spoke no English at home. Half of the women (49%) reported up to eight years of education, while 35% reported at least nine years of education up to technical or vocational school, and 16% had at least some college education.

Participants reported a mean of 1.1 (SD = 2.0, range 0–20) negative life events and 0.5 (SD = 1.1, range 0–8) positive life events during the previous year, which is consistent with the inclusion of a larger number of negative than positive events assessed in the Life Experiences Survey. Mean impact rating score for negative life events was 2.0 (SD = 3.9, range 0–36), compared with 0.9 (SD = 2.3, range 0–16) for positive life events. Mean Migration-Acculturation Stressor Scale score was 36.5 (SD = 10.7), ranging from 22.0 to 74.2.

Correlations Among Acculturation, Stress, and Dietary Variables

Positive and negative event impact rating scores were correlated ($r=0.25$, $p<0.0001$) (see Table 2). Migration-related stress was more strongly correlated with negative ($r=0.34$, $p<0.0001$) than with positive ($r=0.20$, $p<0.0001$) impact rating scores. Acculturation score was correlated with both negative ($r=0.30$, $p<0.0001$) and positive ($r=0.23$, $p<0.0001$) impact rating scores, but not significantly with migration-related stress ($r=0.08$, $p=0.11$).

With respect to dietary variables of interest, positive event impact score was weakly correlated with energy density ($r=0.11$, $p=0.02$) and percent of energy from fat ($r=0.13$, $p=0.007$). Negative life event impact score, migration-related stress, acculturation, and level of education were all positively correlated with energy density and percent of energy from fat, and inversely correlated with intake of grams, percent of energy from carbohydrates, and weekly servings of grains. Energy intake was also positively correlated with level of education ($r=0.15$, $p=0.002$).

Associations between Stress and Dietary Variables

With respect to dietary intake, regression models indicated that higher positive life event impact score was associated with greater total energy intake (Table 3); each one-point increment in positive event impact score was associated with an increase of 21.1 kcal/day (p=0.04). Migration-related stress was also related to dietary intake. Every one-point increment in this score was associated with higher energy density, a 0.06 percentage point increase in energy from fat, daily intake of 11.3 fewer grams of food (p<0.0001), and 0.2 fewer weekly servings of grains (p=0.03). Further, for total grams, the addition of the stress variables accounted for meaningful variance in the model over and above that explained by acculturation alone ($\Delta R^2 = 0.04$, $F_{\Delta}(3,417)= 6.56$, $p<0.001$). P-values for the interaction of migration-related stress with acculturation were statistically significant for intake of grams (p=0.04) and energy density (p=0.008), and suggestive of an interaction for percent of energy from fat (p=0.11).

To illustrate each interaction, we plotted them according to the guidelines specified by Aiken and West (42), using 1 SD below and above the mean, respectively, to represent low and high acculturation level (Figure 1). The inverse association between migration-related stress and gram intake was more pronounced among less acculturated women. In addition, greater migration-related stress was associated with higher energy density and greater percent of energy from fat, but primarily among less acculturated women (Figure 1).

Discussion

In the present sample of Chinese immigrant women, positive life events were associated with greater energy intake, but migration-related stress was associated with lower overall gram intake, lower intake of grains, higher energy density, and a greater percent of energy from fat, especially among less acculturated women. These findings suggest that with exposure to migration-related stress, Chinese immigrant women eat less food but select foods that are higher in fat.

In previous studies, exposure to stress has been associated with both increased and decreased food intake (21,43), increased snacking (25,26), and shifts in food selection. Indeed, accumulating data suggest that, under conditions of stress, humans prefer highly palatable foods that are energy dense (21) – in particular, increased consumption of high-fat, high-sugar foods (17,19,44,45) and a reduction in main meals and vegetable consumption (19,45). There may be both physiologic and behavioral reasons for such observations. For example, a preference for highly palatable, energy-dense foods has been attributed to hormones released during the stress response, such as cortisol (46). Behaviorally, it has been proposed that individuals have less time and energy to devote to the preparation of foods during periods of stress; therefore, an increased reliance on pre-processed convenience foods, which are often energy dense, may also contribute to such findings (47). Indeed, a study of eating behaviors among African Americans reported that stress was associated with haphazard meal planning (20).

Our findings, based on detailed, quantitative dietary data from multiple 24-hour recalls, suggest that positive life events are associated with a general, overall increase in energy intake. Although this finding was somewhat unexpected, we speculate that the presence of positive events (e.g., parties, new job, gaining a new family member either through marriage or birth) is often accompanied by celebrations involving food. Negative life events were not associated with dietary factors in our sample, but migration-related stress appeared to decrease overall eating, as evidenced by its inverse association with total gram intake. It was also associated with higher energy density and percent of energy from fat, particularly among less acculturated women, and with a lower consumption of grains, suggesting a shift

towards unhealthier dietary behaviors. That we observed an association of stress only with grains and not with other foods may be because grains were by far the most frequently consumed food group (32.8 servings/week), and its consumption may have been the most readily reduced in response to stress. Notably, we observed a suggestive inverse association of migration-related stress with intake of vegetables, the next most frequently consumed food group (23.1 servings/week), but this association did not reach statistical significance ($\beta=-0.09$, $p=0.09$, data not shown). Foods for which we might have expected to see some association, such as pastries and chips, were consumed by so few women in our sample that associations with these foods would have been difficult to detect.

Our findings on acculturative stress and dietary behaviors are similar to those reported in studies of mental health outcomes among Asian Americans, in which acculturative stress was a significant predictor of depression even after accounting for general perceived stress (16). It may be that acculturative stress is experienced in a different manner than general stressors, perhaps because acculturative stress may pervade throughout all aspects of one's identity and lifestyle (e.g., culturally, socially, and behaviorally). That migration-acculturation stress was more clearly associated with dietary outcome variables despite its correlation with negative life event impact score suggests the importance of assessing stressors specific to migration in immigrant populations and is an area that warrants further investigation.

A novel finding from our analysis is the possibility that level of acculturation moderates the association between stress and eating behavior. An association of migration-related stress with gram intake was more salient among less acculturated women than among their more acculturated counterparts, and an association with energy density was apparent only in less acculturated women. These associations suggest that with exposure to stress, less acculturated women did not increase their overall gram intake but rather selectively increased their relative intake of energy-dense foods. The associations are also contrary to our expectation that stronger associations would be apparent in the more acculturated women. The more acculturated women in our sample women appeared to have a more mainstream American dietary profile overall compared with less acculturated women, as evidenced by significant correlations of acculturation with energy density and percent of calories from fat of their diets, and an inverse correlation with intake of grains. This subtle dietary shift in more acculturated women may be masking associations of these dietary variables with stress in these women. The different eating behaviors that we observed in more vs. less acculturated women in our sample may also be relevant to the broad observation in other populations that less acculturated immigrants have better health status than their more acculturated counterparts (48,49). Nevertheless, it should be pointed out that intake levels in the present sample overall (mean of 24% of energy from fat, 3.2 servings of vegetables a day excluding potatoes) are still substantially different from national norms (mean of 34% of energy from fat (50), ~2.3 servings of vegetables a day excluding potatoes (51)). Worth emphasizing is that participants in this study were a low-acculturation sample in general, and further changes in their eating habits and dietary responses to stress might be expected over time.

In our sample, more acculturated women reported more life events, suggesting the possibility of confounding. However, study analyses controlled for level of acculturation to minimize this as a concern. An additional limitation is that the sample was relatively homogenous with respect to age, and therefore, it is unknown whether the associations observed would differ among younger immigrant women who may be quicker to adopt American-style eating habits. Third, the cross-sectional nature of the data does not allow us to draw any inferences on the proposed direction of the association between stress and dietary intake. Fourth, although we used standard, multiple-pass procedures to minimize

misreporting, underestimation of energy intake is common, and underreporters tend to report a higher percent of energy from protein (52); thus, dietary measurement error may have diminished our ability to detect associations. Additionally, it is acknowledged that construct validity of the abridged, 11-item acculturation scale could not be more rigorously evaluated; in an *ad hoc* evaluation of construct validity, the abridged scale was significantly correlated with length of residence (Pearson's r=0.17, p=0.0004) and inversely correlated with age at migration (r=−0.14, p=0.004), and it was moderately and significantly correlated with a global indicator of American cultural orientation ('Overall I am American') (r=0.27, p<0.0001). Further, other variables that were not assessed in the present study, such as depression, may also influence dietary behaviors. Assessments to further distinguish the types of stressors experienced (e.g., ego-threatening, such as fear of criticism or failure, versus physical, such as illness or threat of attack) and types of eaters in the sample (e.g., restrained, emotion, or external) were also not available in the present study, and these may moderate associations with dietary response variables as reported in prior studies (19).

Finally, the present study focused on a low acculturation sample of female Chinese immigrants, and therefore the generalizability of findings to men and other immigrant populations is unknown. However, a strength of the study is its inclusion of detailed measures of general life event stress and migration-specific stress as correlates of dietary intake in a natural (as opposed to laboratory-based) setting. The study is the first to specifically examine migration-related stress in relation to dietary intake in an immigrant sample. In addition, detailed, quantitative dietary data were collected to assess differences in dietary intake, rather than self-reported changes in selected aspects of the diet. As such, the present sample offers unique data from an understudied and highly informative population in transition, and thus, findings from this work can be used as the basis to extend this research to other recently immigrated populations.

Our findings suggest that the women in our sample decreased their overall gram intake with exposure to stress. Further, while both stress and acculturation have been independently studied in relation to changes in diet, this is one of the first studies to examine how acculturation may moderate the association between stress and dietary intake. Results indicate that associations of lower gram intake, higher energy density, and greater percent of energy from fat were more pronounced among less acculturated women in our sample. Our data add to the extant literature on how stress, and particularly migration-related stress, may be associated with overall health by affecting composition of food intake among immigrant populations. These findings contribute to a greater understanding of the nuanced and complex relations that may shape food choices and eating behaviors in a Chinese immigrant population, which could have implications for immigrants' future health and risk for chronic diseases.

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References

1. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. Jama. 303:235–241. [PubMed: 20071471]

2. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. Jama. 2004; 292:2860–2867. [PubMed: 15598917]
3. Pan Y, Dixon Z, Himburg S, Huffman F. Asian students change their eating patterns after living in the United States. Journal of the American Dietetic Association. 1999; 99:54–57. [PubMed: 9917732]
4. Satia JA, Patterson RE, Kristal AR, et al. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. Journal of the American Dietetic Association. 2001; 101:548–553. [PubMed: 11374348]
5. Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. Journal of the American Dietetic Association. 2004; 104:771–778. [PubMed: 15127063]
6. 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; 110:457–462. [PubMed: 20184998]
7. Kandula NR, Diez-Roux AV, Chan C, et al. Association of acculturation levels and prevalence of diabetes in the multi-ethnic study of atherosclerosis (MESA). Diabetes Care. 2008; 31:1621–1628. [PubMed: 18458142]
8. Park SY, Murphy SP, Sharma S, Kolonel LN. Dietary intakes and health-related behaviours of Korean American women born in the USA and Korea: the Multiethnic Cohort Study. Public Health Nutr. 2005; 8:904–911. [PubMed: 16277807]
9. Pierce BL, Austin MA, Crane PK, et al. Measuring dietary acculturation in Japanese Americans with the use of confirmatory factor analysis of food-frequency data. Am J Clin Nutr. 2007; 86:496–503. [PubMed: 17684224]
10. Yang EJ, Chung HK, Kim WY, Bianchi L, Song WO. Chronic diseases and dietary changes in relation to Korean Americans' length of residence in the United States. J Am Diet Assoc. 2007; 107:942–950. [PubMed: 17524714]
11. Rogler LH, Cortes DE, Malgady RG. Acculturation and mental health status among Hispanics: Convergence and new directions for research. American Psychologist. 1991; 46:585–597. [PubMed: 1952420]
12. Berry J, Kim U, Minde T, Mok D. Comparative studies of acculturative stress. International Migration Review. 1987:491–511.
13. Ying Y. Immigration satisfaction of Chinese Americans: Am empirical examination. Journal of Community Psychology. 1996:3–16.
14. Dohrenwend, B.; Dorhrenwend, B. Stressful life events: Their nature and effects. New York: Wiley; 1967.
15. Paykel, E.; Cooper, Z. Life events and social stress. In: Paykel, E., editor. Handbook of affective disorders. 2. New York: Guilford Press; 1992. p. 149-170.
16. Hwang WC, Ting JY. Disaggregating the effects of acculturation and acculturative stress on the mental health of Asian Americans. Cultur Divers Ethnic Minor Psychol. 2008; 14:147–154. [PubMed: 18426287]
17. Ng DM, Jeffery RW. Relationships between perceived stress and health behaviors in a sample of working adults. Health Psychology. 2003; 22:638–642. [PubMed: 14640862]
18. Nishitani N, Sakakibara H. Relationship of obesity to job stress and eating behavior in male Japanese workers. Int J Obes (Lond). 2006; 30:528–533. [PubMed: 16247505]
19. O'Connor DB, Jones F, Conner M, McMillan B, Ferguson E. Effects of daily hassles and eating style on eating behavior. Health Psychology. 2008; 27:S20–31. [PubMed: 18248102]
20. Sims R, Gordon S, Garcia W, et al. Perceived stress and eating behaviors in a community- based sample of African Americans. Eat Behav. 2008; 9:137–142. [PubMed: 18329591]
21. Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. Nutrition. 2007; 23:887–894. [PubMed: 17869482]
22. Toyoshima H, Masuoka N, Hashimoto S, et al. Effect of the interaction between mental stress and eating pattern on body mass index gain in healthy Japanese male workers. Journal of Epidemiology. 2009; 19:88–93. [PubMed: 19265270]
23. Hellerstedt WL, Jeffery RW. The association of job strain and health behaviours in men and women. International Journal of Epidemiology. 1997; 26:575–583. [PubMed: 9222783]

24. Wardle J, Steptoe A, Oliver G, Lipsey Z. Stress, dietary restraint and food intake. Journal of Psychosomatic Research. 2000; 48:195–202. [PubMed: 10719137]
25. Conner M, Fitter M, Fletcher W. Stress and snacking: A diary study of daily hassles and between-meal snacking. Psychol Health. 1999; 14:51–63.
26. O'Connor DB, O'Connor RC. Perceived changes in food intake in response to stress: the role of conscientiousness. Stress Health. 2004; 20:279–291.
27. Teegarden SL, Bale TL. Effects of stress on dietary preference and intake are dependent on access and stress sensitivity. Physiology and Behavior. 2008; 93:713–723. [PubMed: 18155095]
28. Rowland NE, Antelman SM. Stress-induced hyperphagia and obesity in rats: a possible model for understanding human obesity. Science. 1976; 191:310–312. [PubMed: 1246617]
29. Dallman MF, Pecoraro NC, la Fleur SE. Chronic stress and comfort foods: self-medication and abdominal obesity. Brain, Behavior, and Immunity. 2005; 19:275–280.
30. Pecoraro N, Reyes F, Gomez F, Bhargava A, Dallman MF. Chronic stress promotes palatable feeding, which reduces signs of stress: feedforward and feedback effects of chronic stress. Endocrinology. 2004; 145:3754–3762. [PubMed: 15142987]
31. Greeno CG, Wing RR. Stress-induced eating. Psychological Bulletin. 1994; 115:444–464. [PubMed: 8016287]
32. Ying, Y. Psychometric Properties of the Migration-Acculturation Stressor Scale in Chinese Taiwanese international students. 2003.
33. Ying YW, Han M. The contribution of personality, acculturative stressors, and social affiliation to adjustment: A longitudinal study of Taiwanese students in the United States. International Journal of Intercultural Relations. 2006; 30:623–635.
34. Sarason IG, Johnson JH, Siegel JM. Assessing the impact of life changes: development of the Life Experiences Survey. Journal of Consulting and Clinical Psychology. 1978; 46:932–946. [PubMed: 701572]
35. Munoz, RF.; Ying, Y. The Prevention of Depression: Research and Practice. Baltimore, MD: The Johns Hopkins University Press; 1993.
36. 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; 31:302–332.
37. Ying Y. Migration and cultural orientation: An empirical test of the psychoanalytic theory in Chinese Americans. Journal of Applied Psychoanalytic Studies. 2001; 3:409–430.
38. US Department of Health and Human Services, US Department of Agriculture. Dietary Guidelines for Americans, 2005. 6. Washington, DC: US Government Printing Office; 2005.
39. US Department of Agriculture. MyPyramid.gov. Retrieved December 8, 2009; from http://www.mypyramid.gov/index.html
40. Food and Drug Administration. Food and Drugs: Food Labeling. p. 21
41. Kornblith AB, Herndon JE 2nd, Zuckerman E, et al. Social support as a buffer to the psychological impact of stressful life events in women with breast cancer. Cancer. 2001; 91:443–454. [PubMed: 11180093]
42. Aiken, LS.; West, SG. Multiple regression: Testing and interpreting interactions. Newbury Park: Sage; 1991.
43. Oliver G, Wardle J. Perceived effects of stress on food choice. Physiology and Behavior. 1999; 66:511–515. [PubMed: 10357442]
44. Oliver G, Wardle J, Gibson EL. Stress and food choice: a laboratory study. Psychosomatic Medicine. 2000; 62:853–865. [PubMed: 11139006]
45. Mikolajczyk RT, El Ansari W, Maxwell AE. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. Nutr J. 2009; 8:31. [PubMed: 19604384]
46. Takeda E, Terao J, Nakaya Y, et al. Stress control and human nutrition. Journal of Medical Investigation. 2004; 51:139–145. [PubMed: 15460899]
47. Prentice AM, Jebb SA. Fast foods, energy density and obesity: a possible mechanistic link. Obes Rev. 2003; 4:187–194. [PubMed: 14649369]

48. Perez-Escamilla R. Dietary quality among Latinos: is acculturation making us sick? J Am Diet Assoc. 2009; 109:988–991. [PubMed: 19465179]

49. Escobar JI. Immigration and mental health: why are immigrants better off? Archives of General Psychiatry. 1998; 55:781–782. [PubMed: 9736003]

50. Freedman LS, Guenther PM, Dodd KW, Krebs-Smith SM, Midthune D. The population distribution of ratios of usual intakes of dietary components that are consumed every day can be estimated from repeated 24-hour recalls. J Nutr. 140:111–116. [PubMed: 19923394]

51. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc. 2006; 106:1371–1379. [PubMed: 16963342]

52. Poslusna K, Ruprich J, de Vries JH, Jakubikova M, van't Veer P. Misreporting of energy and micronutrient intake estimated by food records and 24 hour recalls, control and adjustment methods in practice. Br J Nutr. 2009; 101(Suppl 2):S73–85. [PubMed: 19594967]

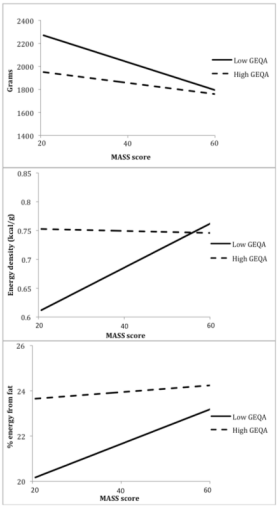

Figure 1.

Moderation of associations between Migration-Acculturation Stressor Scale (MASS) score and dietary variables by level of acculturation. Lines show regression lines assuming General Ethnicity Questionnaire-American (GEQA) scores of 1 SD above and below the mean, representing ‘high’ and ‘low’ values, respectively. Mean MASS score was added to the centered values in the graph for purpose of presentation.

Table 1

Descriptive characteristics of study sample (N=426).

	%
Born in China (%)[a]	97
Married (%)	93
Education (%)	
<8 years	49
9–12 years / technical school	35
at least some college	16
Speak English at home* (%)	
Not at all	69
A little	22
Somewhat or higher	9
	Mean (SD)
Age (years)	43.9 (4.5)
Length of US residence (years)	7.5 (4.8)
Age at migration (years)	36.4 (6.5)
General Ethnicity Questionnaire score	2.1 (0.7)
Number of positive life events	0.5 (1.1)
Impact rating score for positive life events	0.9 (2.3)
Number of negative life events	1.1 (2.0)
Impact rating score for negative life events	2.0 (3.9)
Migration-Acculturation Stressor Scale score	36.5 (10.7)
Daily intake	
Energy (kcal)	1354 (353)
Grams	1811 (568)
Energy density (kcal/g)	0.79 (0.23)
Fat (% energy)	24.3 (6.0)
Carbohydrate (% energy)	55.6 (8.2)
Protein (% energy)	20.0 (4.3)
Servings per week of grains	32.8 (16.4)

[a] N=425 for birthplace and language use, due to missing values.

Table 2

Spearman correlations among variables of interest.

	1	2	3	4	5	6	7
1. positive events impact rating score	1.0	-	-	-	-	-	-
2. negative events impact rating score	0.25***	1.0	-	-	-	-	-
3. Migration-Acculturation Stressor Scale score	0.20***	0.34***	1.0	-	-	-	-
4. General Ethnicity Questionnaire-American score	0.23***	0.30***	0.08	1.0	-	-	-
5. age	0.07	0.10*	0.04	0.01	1.0	-	-
6. length of US residence	−0.14**	−0.02	−0.36***	0.14**	0.02	1.0	-
7. level of education	0.14**	0.05	−0.02	0.40***	−0.01	0.01	1.0
Dietary variables							
8. energy	0.09	−0.03	−0.09	0.06	0.06	−0.05	0.15**
9. grams	−0.03	−0.17***	−0.19***	−0.22***	0.06	−0.01	−0.15**
10. energy density	0.11*	0.14**	0.12*	0.26***	−0.003	−0.02	0.28***
11. % energy from fat	0.13**	0.18***	0.15**	0.25***	−0.03	−0.04	0.21***
12. % energy from carbohydrates	−0.07	−0.18***	−0.10*	−0.21***	0.02	0.001	−0.14**
13. % energy from protein	−0.05	0.09	−0.01	0.05	0.01	0.03	−0.02
14.servings/week of grains	−0.05	−0.13**	−0.14**	−0.18***	0.11*	−0.05	−0.07

* p<0.05

** p<0.01

*** p<0.001

Table 3

Adjusted beta estimates[a] (p-values) for positive and negative life event rating scores and Migration-Acculturation Stressor Scale score in sample of US Chinese immigrant women (N=426).

	Negative life events impact score	Positive life events impact score	Migration-Acculturation Stressor Scale score
Energy (kcal)	−2.7 (0.65)	**21.1 (0.04)**	−3.3 (0.09)
Interaction p[b]	0.93	0.59	0.34
Grams	−5.1 (0.56)	10.5 (0.49)	**−11.3 (<0.0001)**
Interaction p	0.50	0.88	**0.04**
Energy density (kcal/g)	−0.001 (0.97)	0.006 (0.39)	**0.002 (0.04)**
Interaction p	0.38	0.76	**0.008**
Fat (% energy)	0.02 (0.82)	−0.05 (0.75)	0.06 (0.05)
Interaction p	0.70	0.92	0.11
Carbohydrate (% energy)	−0.11 (0.41)	0.27 (0.25)	−0.04 (0.32)
Interaction p	0.93	0.64	0.68
Protein (% energy)	0.10 (0.17)	−0.20 (0.11)	−0.01 (0.57)
Interaction p	0.60	0.41	0.22
Grains (servings/week)	−0.14 (0.59)	0.57 (0.21)	**−0.18 (0.03)**
Interaction p	0.87	0.19	0.50

[*] Models included positive life event impact rating score, negative life event impact rating score, Migration-Acculturation Stressor Scale score, age, marital status (married vs. unmarried), level of education (0–8 years, 9–12 years, at least some college), length of US residence, and General Ethnicity Questionnaire score. Beta estimate represents mean change in dietary outcome variable for each one-unit change in continuous stress variable score.

[**] P-value estimated for cross-product term (centered, continuous General Ethnicity Questionnaire score x stress variables) in adjusted hierarchical regression models.