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Disentangling the Effects of Migration, Selection and Acculturation on Weight and Body Fat Distribution: Results from a Natural Experiment involving Vietnamese Americans, Returnees, and Never-leavers

Hongyun Fu, Ph.D.¹ and Mark J. VanLandingham, Ph.D.²

¹Population Services International, Kunming, China

²Tulane University, School of Public Health and Tropical Medicine, New Orleans, LA

Abstract

Objective—We distinguish between selection and true migration effects on weight and body fat for Vietnamese immigrants; and examine the role of acculturation on these outcomes.

Methods—Data (n=703) were collected among three population-based samples of working-age Vietnamese immigrants, repatriated emigrants and never-migrated Vietnamese nationals. This allows for a decomposition exercise to separate the effects of migration effects from selection effects on body mass index (BMI) and waist-hip ratio (WHR).

Results—Immigrants are more likely to be overweight and to have high WHR, relative to both never-leavers and returnees, a pattern reflecting the importance of migration over selection. Among immigrants, coming to the US at a younger age is associated with higher BMI and WHR levels. And longer length of residence in the US is related to higher BMI. While higher Vietnamese language proficiency is related to a lower BMI level, being bilingual (proficient in both English and Vietnamese) is associated with lower risks for being overweight.

Conclusions—The distinct pattern of results suggests that more problematic weight status and fat distribution among Vietnamese immigrants relative to Vietnamese nationals are not artifacts of the types of persons choosing to emigrate, but rather are due to acculturation to American diet and lifestyles. While efforts to promote and maintain traditional patterns of diet and lifestyle are likely to help Vietnamese and other immigrants avoid the perils of American patterns, facilitating a bi-cultural orientation is perhaps the most realistic approach for preserving protective features of the culture of origin with regard to body weight and fat distribution.

Keywords

immigrant health; obesity; selection effect; migration; acculturation; Vietnamese Americans

BACKGROUND

Obesity is the second leading cause of preventable death in the United States (US), and disproportionately affects minorities and low income communities (Mokdad 2000; Ogden *et al.* 2002; 2006; American Obesity Association 2004; Candib 2007). Asian immigrants come from countries where obesity is less widespread; and they generally have lower BMI levels than the US natives (Lauderdale and Rathouz 2000; Misra and Ganda 2007; Kaushal 2009).

However, recent studies reported a drastic increase in the incidence of obesity as well as obesity-associated chronic health problems including cardiovascular diseases, hypertension and diabetes among Asian Americans, particularly those who have had an extended length of stay in the US (Singh and Siahpush, 2001; 2002; Goel *et al.* 2004; Kaplan *et al.* 2004; McNeely and Boyko 2004; Dey and Lucas 2006; Bates *et al.* 2007). Migration and acculturation into the culture of the host country have been reported to be major catalysts of problematic weight gain among immigrants (Salmond *et al.* 1985; 1989; McGarvey 1991; Hazuda *et al.* 1988; 1991; Sundquist and Winkleby 2000; Iacoviello *et al.* 2001; Davis *et al.* 2004; Misra and Ganda 2007). Empirical investigations which address this association among Asian Americans, however, are rare, and the body of empirical work on immigrants more generally is hampered by inherent limitations imposed by conventional approaches that lack appropriate comparison groups in their study design.

The “acculturation hypothesis” implicates acculturation as the key mechanism linking migration with health status (Lauderdale and Rathouz 2000; Goel *et al.* 2004; Kaplan *et al.* 2004; Abraido-Lanza *et al.* 2005; Dey and Lucas 2006; Koya and Egede 2007). An increasing length of residence in the host environment will eventually lead to increasing similarity between immigrants and natives with regard to lifestyle, social norms and health practices, and ultimately, health and disease profiles (Lauderdale and Rathouz 2000; Salant and Lauderdale 2003; McDonald and Kennedy 2004; 2005). In particular, an elevated risk of obesity among immigrants – including Asian immigrants – stems from their adaptation to American dietary patterns and lifestyles (McDonald and Kennedy 2005; Misra and Ganda 2007, Liou and Bauer 2007). Specifically, increasing familiarity and use of foods high in calories, saturated fat, and simple sugars; and low in dietary fiber, fruits, and vegetables reflect a nutritional transition among immigrants away from their traditional diets (Lee *et al.* 1994; Palinkas and Pickwell 1995; Landman and Cruickshank 2001; Gordon-Larsen *et al.* 2003; Lv and Cason 2004; Novotny *et al.* 2009).

A less physically-active lifestyle in the host country further contributes to an elevated risk for overweight/obesity (Lee *et al.* 1994; Goel *et al.* 2004; Unger *et al.* 2004; McDonald and Kennedy 2005). Less physical activity and more sedentary activities, such as TV/video viewing and computer/video game use, were reported among immigrants who had an extended length of residence in the US, relative to their peers with shorter durations in the US and peers living in their countries of origin. Similarly, second-generation immigrants are more sedentary than first generation immigrants (Lee *et al.* 1994; Wolin *et al.* 2006; Franzen and Smith 2009; Afable-Munsuz *et al.* 2010). Ironically, it is successful adaptation and acculturation to the host country that leads to more problematic body weight. Individuals with a high degree of interaction with the host population and with a high level of assimilation to American culture are more susceptible to overweight/obesity than are those with lower levels of integration (Song *et al.* 2004; McDonald and Kennedy 2005). Immigrants’ social networks within their ethnic groups temper the assimilation process; and consequently lower their overweight/obese risks (Song *et al.* 2004; McDonald and Kennedy 2005). Compounding these problems associated with the acquisition of an increasingly inactive lifestyle, psychological stresses associated with immigration, including language barriers, declines in status, economic hardships, and racial discrimination can induce hormonal and metabolic changes associated with weight and fat accumulation (Rosmond *et al.* 2000; Kalra *et al.* 2004; Gee *et al.* 2008).

Empirical evidence supporting these hypothesized links among migration, acculturation, and weight gain come from three general areas of research. The first area focuses on the relationship between length of residence and obesity risk. While lower obesity levels were generally found among foreign-born immigrants relative to US natives, the odds of being overweight/obese significantly increase after an extended length of stay in the US

(Lauderdale and Rathouz 2000; Singh and Siahpush, 2002; Goel *et al.* 2004; Kaplan *et al.* 2004; Goel *et al.* 2004). Studies based on National Health Interview Survey (NHIS) find a strong association between longer lengths of stay in the US and excess weight gain among Asian immigrants (Lauderdale and Rathouz 2000; Kaplan *et al.* 2004; Goel *et al.* 2004; Abraido-Lanza *et al.* 2005; Dey and Lucas 2006; Koya and Egede 2007). Goel *et al.* (2004) revealed that the initial Asian immigrant weight-related health advantage (*i.e.*, lower weight) significantly declined among those who had lived in the US for 10 years or more (Goel *et al.* 2004). The prevalence of being overweight among those who have lived in the US up to 15 years becomes close to that of the US general population (Goel *et al.* 2004). In addition, higher risks for overweight/obesity are commonly found among immigrants who have lower educational levels and who came to the US at a younger age (Surgeon General 2001; Roshania *et al.* 2008; Kaushal 2009).

The second area of research focuses on change across generations. These studies show a clear generational pattern of obesity increase within immigrant families (Fujimoto *et al.* 1994; Popkin and Udry 1998; Gordon-Larsen *et al.* 2003; Bates *et al.* 2007). Relative to first generation immigrants, second and third generation immigrants suffer higher obesity levels (Popkin and Udry 1998; Gordon-Larsen *et al.* 2003; Bates *et al.* 2007; Van Hook and Balistreri 2007). Bates *et al.* (2007) analyzed data from 2002–2003 National Latino and Asian American Survey (NLAAS) and found that both Asian and Hispanic American adolescents are more than twice as likely to be obese as the first-generation immigrants from their countries of origin. The levels of obesity among the third generation Filipinos and Latinos become similar to or even higher than that of the native US population (Bates *et al.* 2007).

The third area of research involves comparisons between immigrants and their non-migrant counterparts in the sending countries. Several existing studies document a higher prevalence of obesity and some chronic health problems among immigrants living in the West than among their counterparts back home (Lee *et al.* 1994; Bhatnagar *et al.* 1995; Araneta *et al.* 2006; Patel *et al.* 2006). Patel *et al.* (2006) found a greater dietary energy and fat intake, a higher mean BMI and a higher risk for CHD among Indian migrants living in Britain, as compared to Indians who remained in their country of origin. Similarly, Araneta *et al.* (2006) reported a lower level of BMI among non-migrant Filipina women in the Philippines, relative to Filipina migrants in Hawaii and San Diego.

A major limitation of these existing studies is that their results are potentially confounded by a migration selection effect. Observed differences in health status between migrants and non-migrants occur in part because there are several points at which individuals who go on to become migrants are differentiated from those who do not. These pre-existing differences culminate in the decision to migrate. Those who decide to do so differ profoundly from those who do not, and some of these differences are surely correlated with health status, in both positive and negative ways. Individuals who chose to emigrate did so in part because they were healthy enough to do so. Migrants may be more adventurous than non-migrants and willing to undertake the rigors and hardships that immigration entails (Hull 1979; Stern and Wei 1999; Singh and Siahpush 2002; Jasso *et al.* 2004; Antecol and Bedard 2006). Immigrants are screened on medical and other health-related criteria before entry, which will also serve to discourage or prevent those with health problems from migrating (Hull 1979; Abraido-Lanza *et al.* 1999; Stern and Wei 1999; Palloni and Arias 2004; McDonald and Kennedy 2004). Finally, individuals who are unhealthy or economically less successfully may be more likely to return home (Palloni and Arias 2004; Antecol and Bedard 2006).

More negatively, a propensity or tolerance for risk-taking among those who choose to migrate may also subject them to a wide range of hazards that less adventuresome

individuals may avoid, *e.g.*, sexual risk-taking, risky driving, extensive drug and alcohol use, and the adoption of new lifestyles. To understand whether elevated obesity risks among immigrants are truly attributable to migration – rather than selection – it is essential to compare immigrants with those living in the countries of origins who share similar characteristics (both observed and unobserved), but, by chance, did not or were not allowed to emigrate (Lindstrom and Massey 1994; Stillman *et al.* 2009; Fu and VanLandingham 2012).

Experimental investigations of this nature are nonexistent, since the random assignment of individuals to experimental (migrant) and control (remain behind) groups is unfeasible for both practical and ethical reasons. Our approach is to exploit a major change in Southeast Asian refugee resettlement policy as a “natural experiment” to address the potential confounding influences of pre-migration selection factors upon obesity risks among Vietnamese immigrants. Before the change in policy in June of 1989, essentially all refugees who departed Vietnam and reached a first asylum camp were eventually settled in the West. After the change, only the small proportion who could prove a genuine risk of persecution upon return were accepted for resettlement; everyone else was repatriated to Vietnam. Thus, those who left Vietnam but reached the first asylum camps after June 1989 (and were repatriated) share many characteristics with those who left but reached the first asylum camps before 1989 (and were settled abroad); members of both groups departed Vietnam with the intention to emigrate. Those who were accepted for resettlement in the West (and became immigrants) and those who were repatriated (and became returnees) went on to live in vastly different social and economic settings (the US and Vietnam, respectively). But the returnees went on to share the same environment (the same neighborhoods in Vietnam) as the never-leavers. Thus, this June 1989 change in resettlement policy provides substantial leverage on migration, selection and contextual factors that generally confound comparisons between immigrants and other groups on health status.

Vietnamese migration stemming from the war in Indochina

The upheaval near the end of the Southeast Asian wars of the 1960s and 1970s displaced countless Vietnamese families from their homes (Banister 1993; Zhang *et al.* 2001), many permanently. Many Vietnamese emigrated to the US and other receiving countries during this period (Montero 1979; Kelly 1977; 1986). This influx has resulted in the Vietnamese becoming the fastest-growing minority population in the US during the 1980s and 1990s (US Census Bureau 2000). The US Census has documented over 1.2 million Vietnamese Americans in the US by 2000, among whom around 923,000 are foreign born Vietnamese immigrants (Reeves and Bennett 2004).

This exodus of Vietnamese is often characterized as occurring in three waves (Stone and McGowan 1980; Kelly 1986; Campi 2005). The initial wave started just before the collapse of the South Vietnamese government in 1975 and included many former South Vietnamese military and civilian officials and their families, who escaped with the help of their US allies. The second wave, which occurred between 1978 and the early 1980s, was a massive exodus of clandestine emigrants by both land and sea, resulting from discontent with the new regime and post-war political and societal upheaval and with the hope of resettlement in the west. This wave included many rural farmers or fisherman as well as many ethnic Chinese. Many evacuees suffered terribly during their escape, and untold numbers perished (Fox *et al.* 1995).

In part to stem this dangerous exodus of “boat people” from Vietnam, the United Nations convened the First Geneva Conference on Indochinese Refugees in July 1979 (Stein 1979), resulting in the Orderly Departure Program (ODP). The underlying principle of the ODP was that countries of first asylum would continue to provide temporary asylum to refugees

who arrived on their shores or borders; and that the resettlement countries would accept those who had departed their countries and reached an asylum country.

However, this agreement collapsed in the late 1980s, when the countries of ultimate destination implemented much more selective criteria (UNHCR 1989; Helton 1993). The new policy, the Comprehensive Plan of Action (CPA), was implemented in June 1989, and maintained that “mechanisms should be developed to determine the claims of new arrivals to refugee status on a regional basis” (UNHCR 1989; Bronee 1993). This was a dramatic change in policy, before which, nearly all refugees were accepted for re-settlement in the West; after which, only about a quarter of newly arriving refugees were accepted for resettlement (Robinson 1998). The rejected asylum seekers (over 110,000) were repatriated back to Vietnam (UNHCR 2002). The third wave of re-settlement consisted of a fairly small number of immigrants (about 20,000) accepted for resettlement under the goal of family reunification with relatives already in the US (Zhou and Bankston 1998).

METHODS

Study Design

Our major population of interest is Vietnamese immigrants living in New Orleans. The employment of two groups of Vietnamese nationals - returnees and never-migrants – along with the major change in immigration policy occurring in June 1989 described above provides useful leverage to ascertain what effects migration *per se* – as opposed to selection – has on obesity risks among Vietnamese immigrants. Before June 1989 essentially all Vietnamese who made it to a country of first asylum were successfully settled in the West (mostly in the US) – those who eventually settled in New Orleans constitutes our Vietnamese immigrant group. For those arriving in the first asylum countries after June 1989, the vast majority were repatriated to Vietnam – those who were repatriated back to Vietnam from the transit country constitute the returnee group. Those who never attempted to emigrate constitute the never-migrant group. Comparing the *returnees* with the *never-migrants* provides an estimate of the effects of selection (the observed and unobserved characteristics that place one at risk of migration) on health outcomes net of migration and contextual effects (since neither group migrated to the US). Comparing the *returnees* to the *immigrants* provides an estimate of the effects of migration and adaptation in the US net of selection effects (since both groups are subject to the same set of selection effects). Most importantly, if *immigrants* differ from both *never-migrants* and *returnees* on levels of BMI and WHR, we can attribute the differences to the effects of migration *per se*, since this is the essential attribute that only the immigrants possess.

Data and sample

Data were collected between 2003 and 2005 using face-to-face interviews. Our sample consists of three distinct population-based sub-samples totaling 703¹ working age adults (23–53 years old), including 124 Vietnamese immigrants living in New Orleans; 134 migration returnees to Vietnam living in Ho Chi Minh City (HCMC), Vietnam; and 445 never-migrants living in the same urban wards in HCMC as do the returnees. The entire set of questions and measurements took about 45 – 90 minutes to complete. Interviewers were thoroughly trained in the collection of all health measures. For data collection among our immigrant respondents, all of our interviewers were bilingual and questionnaires were

¹The original samples included 736 respondents. However, 27 individuals who did not meet the study criterion and 6 individuals with missing information on the key outcomes variables were excluded from the final analysis. The final analyses in this study included a final sample of 703 working age adults.

available in both English and in Vietnamese languages; 38% of our respondents chose to have the interview in English, and 62% preferred Vietnamese.

Our measures included a wide range of social, demographic and economic status indicators, access to care, occupational injury, health behaviors, and various dimensions of health status (see Measures sub-section below). At the end of the interview after the respondent had been sitting for a period of time answering questions, our physical measures - including height, weight, waist and hip circumference, blood pressure and lung capacity - were collected.

Returnees and never-migrants were selected using multi-stage cluster sampling. In Vietnamese, an urban ward (*phường*) consists of several neighborhood clusters or associations (*tổ dân phố*), consisting of about 50 households or less. While these clusters are not official administrative units, they do have a head or leader (*tổ trưởng*). The ward (*phường*) is the smallest official administrative unit in urban areas. HCMC has 19 urban districts containing 259 urban wards. Three of these urban districts known to contain large numbers of returnees were selected for study. In each of the three selected districts, 1 ward was randomly selected. In the selected ward, 3 neighborhoods were randomly selected. For each neighborhood, four clusters were randomly selected, and 12 households were randomly selected from each cluster. A complete listing of all adults in these households was compiled using a list maintained by local ward officials. Eligible respondents had lived in HCMC for at least 20 years and were between 25–49 years of age. If there was more than one eligible respondent within the household, a uniform procedure to randomly select a respondent was implemented. There were two refusals among the never-leavers. Returnees were selected from a listing of all returnees living in the same urban wards as the never-leavers. Our procedure for randomly selecting the returnees ensured that the distribution of returnees across the three urban wards was similar to the distribution of never-leavers across the same wards.

For the immigrant sample, eligible individuals were between the ages of 20–54 during the time of the initial survey (summer of 2005); were born in Vietnam; had arrived in the US between 1975 and 1990; and had been older than 5 years of age when they arrived. These criteria ensure that the respondents were of working age at the time of interview (the ages at which the stresses of immigration and adaptation would be most apparent); that the immigrants would have had significant life experience in both Vietnam and in America; and that they had arrived in a country of first asylum prior to the change in immigration policy in June 1989. A recently-updated population register of Vietnamese-American households in the greater New Orleans area was employed to draw the sample during the summer of 2005. This register is maintained jointly by the principal nongovernmental organization (NGO) and the largest Catholic Church serving the area; it includes both Catholic and non-Catholic Vietnamese families, and lists household members by name. Upon arrival at the household thought to have an eligible respondent (the original registers had a list of residents along with their ages), the interviewer followed a procedure to first list and then randomly select an eligible respondent. Data collection was completed in August 2005. Of the eligible households contacted by our NGO collaborators, 128 completed the interview and 46 refused, yielding a response rate of 74%.

Measures

Our physical measures of health status include respondents' weight, height, and waist and hip circumferences. BMI (kg/m^2) and waist to hip ratio (WHR) are calculated to provide standard measures of weight-for-height and patterns of body fat distribution. The cutoff points of BMI are less than 18.5 for underweight, 18.5–24.9 for normal range, 25–29.9 for overweight, and 30 or above for obese, following the criterion proposed by WHO (WHO Expert Consultation 2004). WHR measures abdominal obesity. The cutoffs for defining

problematic WHR were greater than 0.90 for men and greater than 0.80 for women (Willett *et al.* 1999; Dobbelsteyn *et al.* 2001). High WHR is a marker for heightened psychological stress (Wing *et al.* 1991; Björntorp 1998; Rosmond and Björntorp 1998).

A 17-item acculturation scale, developed specifically for Southeast Asians (Anderson *et al.* 1993), was employed to measure the levels of acculturation among the Vietnamese immigrants in our sample. This scale covers questions on language proficiency and preference for both Vietnamese and English. It also covers food and social contact preferences (Vietnamese versus American). The scale provides two standard subscales to assess the bidirectional acculturation process of immigrants, including assimilation into American culture as well as retention of traditional Vietnamese cultural attributes (Anderson *et al.* 1993). The first subscale is a composite measure of English and Vietnamese proficiency, and includes four categories: (1) Low on both English and Vietnamese, (2) Low on English but high on Vietnamese, (3) Low on Vietnamese but high on English, (4) High on both English and Vietnamese. For our Vietnamese sample, this language proficiency scale was coded into two groups: holding a bi-cultural orientation (proficient in both English and Vietnamese languages) versus a primary orientation towards the culture of origin (proficient only in Vietnamese). Around 90.5 percent of our Vietnamese respondents reported that they could understand, speak and write Vietnamese well or very well. A small proportion of them (9.5%) reported “not too well” either in Vietnamese writing (8%), speaking (4%) or comprehension (2%). Regarding English language skill, much wider variation was reported by our immigrant sample. Only around 41 percent of immigrant respondents reported that they could read, write and understand English well. The second subscale summarizes language, social contacts and food preferences (LSPPF). Higher values indicate being more Americanized. Overall the level of Americanization of our Vietnamese sample is quite low. Taking food preference as an example, only one respondent preferred American food mostly.

In addition, we also employ length of stay in the US and age at immigration, two proxy measures of acculturation that are widely employed in studies focusing on immigrants (Palinkas and Pickwell 1995; Lauderdale *et al.* 2000; Kaplan *et al.* 2004; Goel *et al.* 2004).

Statistical analyses

Our analytical strategy has three steps. First, we present descriptive statistics to illustrate similarities and differences among our three sub-samples with regard to demographic and socioeconomic characteristics as well as our key outcome variables. Second, in order to account for compositional differences across our sub-samples, we estimate a series of multivariate regression models (OLS regression with continuous outcomes and logistic regression with binary outcomes) to examine net associations between migration status and levels of BMI and WHR. Our contrasts between various pairs of our sub-samples in this step also allow us to distinguish between differences that are attributable to changes in context (“real” migration effects) and differences attributable to pre-migration “selection” effects. Third, we estimate an additional set of models for the immigrant sub-sample to explore the effects of acculturation on our obesity-related outcome measures.

RESULTS

Demographic profile

Characteristics of the sub-samples are presented in Table 1. Some compositional differences across the three groups are apparent. At the time of interview, the immigrant population was on average over three years older than the returnees and never-leavers. There are more females among never-leavers, but more males among returnees and immigrants². Never-

leavers are less likely to fall into the “unskilled, service and agricultural” occupational category, and more likely to fall into “entrepreneur” category compared to returnees and immigrants.³ The fairly minor differences in the distribution of marital status are not statistically significant.

As expected, immigrants have on average higher BMI scores (Mean=23.97, Std=3.04) than both never-leavers (Mean=22.10; Std=3.31) and returnees (Mean=22.01, Std=3.25). The overall prevalence of obesity is low among all the three groups (3.2%, 2.7% and 1.5% respectively for immigrants, never-leavers and returnees). However, 36 percent of immigrants are over-weight, over double the proportion of never-leavers and returnees in this category. Similarly, immigrants have a higher WHR than both never-leavers and returnees. The proportion with high WHR among immigrants (77%) is near twice of the rate among never-leavers (40%) and returnees (35%).

Our multivariate results – which adjust for compositional differences in age, sex, occupation and marital status – show similar patterns (see Table 2)⁴. Disadvantages for immigrants with regard to higher levels of BMI and WHR than both returnees and never leavers are maintained. The likelihood of being overweight/obese among immigrants is over twice as high as that of never-leavers (OR=2.16, $p<0.001$) and returnees (OR=2.50, $p<0.001$). In addition, immigrants are over five times more likely to have high WHR than never-leavers (OR=5.09, $p<0.001$) and returnees (OR=5.96, $p<0.001$). Moreover, the pattern of results – consistent disadvantages for immigrants relative to both never-leavers and returnees – indicates that these disadvantages with regard to body weight and fat distribution observed for immigrants are due to the effects of migration *per se* rather than to pre-migration “selection” effects. If selection played a major role, the disadvantages would be observed among the returnees (relative to the never-leavers) as well, since both the immigrants and returnees were pre-disposed to migrate.

Our final set of analyses examines the relationship between acculturation and weight status among Vietnamese immigrants. As expected, our measures of acculturation are highly correlated with each other. We therefore estimate separate multivariate regression models to examine the effect of each acculturation measure on weight status, controlling for age, sex, marital status and occupation. Results (see Table 3) indicate that immigration to the US at an older age is associated with lower BMI (Beta = -0.12, $p=0.04$) and WHR (Beta = -0.003, marginally significant at $p=0.08$). Similarly, those with a longer length of residence in the US (Beta = 0.10, marginally significant at $p=0.09$) and worse Vietnamese language skill (Beta = -0.32, marginally significant at $p=0.09$) have higher BMI levels. However, a higher level of English language skill is associated with a lower risk for having a problematic (high) WHR (OR= 0.76, $p=0.01$), a marker of stress (Wing *et al.* 1991; Rosmond and Björntorp 1998). Higher scores on our acculturation (LSFP) measure means more “Americanized,” and a higher score is associated with our body weight outcomes in the predicted direction (higher levels of acculturation into the US culture are associated with worse outcomes), but none of the results approach statistical significance. One approach for capturing “bicultural acculturation” is to separate out individuals who are bilingual, *i.e.*, who

²Many more men than women left Vietnam after the war; see Goodkind (1997) for a discussion of some of the implications.

³Educational attainment (not shown) also differs among the samples, especially between immigrants and nationals. This is due primarily to better opportunities for educational attainment among immigrants after their arrival in America. We thus employ occupational status as our preferred measure of socioeconomic status throughout the paper.

⁴With regards to socioeconomic factors, older age and being male are consistently and significantly associated with higher levels of BMI and waist-hip ratio, and with higher likelihood of having problematic weight status. Being married is related to a higher likelihood of having high BMI (OR=2.38, $P<0.03$). There is no significant association between occupational status and any of the weight-related health outcomes measured. Adding the control variables in the model only slightly reduced the magnitudes of associations between migration status and our obesity related health outcomes. Migration status is the most significant predictor of weight-related health outcomes in all of the models.

are adept both in English and Vietnamese languages. This characteristic proves to be highly protective against being overweight (Odds ratio = 0.45, marginally significant at $p=0.09$), relative to the rest of the Vietnamese immigrants who are not proficient at both languages (*i.e.*, who are proficient in Vietnamese language only). In another model (not shown) that includes age at immigration as a control variable, the protective effect of being bi-lingual (our proxy measure for being bi-cultural) is even stronger, lowering the odds of being overweight by about two-thirds (Odds ratio = 0.38, marginally significant at $p=0.06$).

CONCLUSIONS AND DISCUSSION

The prevalence of obesity among Vietnamese immigrants is very low compared with the general US population (American Obesity Association 2004), but the rapid divergence between Vietnamese immigrants and nationals with regard to weight status along with the substantial proportions of Vietnamese immigrants who are overweight and/or have high WHR portend an emerging set of health problems for this population. A well-developed body of literature has highlighted the potentially confounding influence of selection effects on differences in health outcomes between immigrants and their counterparts who remain in the country of origin (Hull 1979; Lindstrom and Massey 1994; Palloni and Arias 2004; Antecol and Bedard 2006; Stillman *et al.* 2009). Our analyses indicate that the disadvantages Vietnamese immigrants face with regard to weight status and fat distribution *vis-à-vis* nationals are due to the effects of immigration and acculturation, not to selection. Our analyses that focus on differences in these outcomes among immigrants confirm this general conclusion, but with a twist. Multivariate analysis demonstrates that immigrants who arrived at a younger age and have been in the US for longer periods have poorer outcomes on both BMI and WHR. But we *also* find that immigrants who are comfortable using both Vietnamese and English fare better than those who are comfortable only in Vietnamese. So while more exposure to American cultural patterns is connected with poorer health outcomes, disengagement from the host society – operationalized by a relative inability to effectively engage in both Vietnamese and English – is associated with poor outcomes as well. It is those who are able to navigate both worlds who fare best.

These results have important policy implications. Programs that seek to prevent or reduce health problems related to weight and fat distribution should encourage the maintenance of traditional Vietnamese foods and diets. But it is also important to encourage the acquisition of language and other skills that allow for effective functioning within the host culture. While we do not possess the data required to specify exactly how such acquisition might stave off weight problems among immigrants, we speculate that an ability to function well in the host society will help prevent isolation, unemployment, and depression, which can in turn protect against problems related to weight status (Rosmond and Bjorntorp 1998; Rosmond *et al.* 2000; Kalra *et al.* 2004; Gee *et al.* 2008). Indeed, our continuing study of this same sample of Vietnamese immigrants living in New Orleans has shown that bi-culturalism – *vis-à-vis* being more “Vietnamese” – also has protective benefits for mental health after Hurricane Katrina (Vu *et al.* in press).⁵

Our study has two major limitations. First, our sub-samples are small, limiting our statistical power, especially with regard to how acculturation might affect weight status within a multivariate analysis including only immigrants. Second, our research design is a natural – rather than a true – experiment. We are thus unable to completely rule out all potentially confounding influences that are inherent in cross-sectional studies. For example, the involuntary nature of repatriation and the difficulties associated with return might serve to disadvantage returnees relative to never-leavers.⁶ Also, extended refugee camp experience

⁵The main Vietnamese enclave flooded badly after Hurricane Katrina.

may have long-lasting effects for both the eventual immigrants and returnees (see Norris et al. 2009). Even so, our natural experiment design provides important leverage on the potentially confounding effects of selection bias, which has been a key limitation of previous research focusing on the health consequences of migration. The fact that immigrants face health disadvantages related to weight and fat distribution that neither the returnees nor the never-leavers experience presents a compelling case for ruling out selection. This allows us to focus our efforts on features of the new environment that are amenable to interventions, i.e., the promotion of traditional diets and the acquisition of skills necessary to successfully navigate the new setting.

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⁶On the other hand, returnees received substantial benefits from UNHCR and other organizations that the never-leavers did not receive (UNHCR 2002).

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Table 1

Comparisons on demographic, socioeconomic characteristics and weight status across three samples (N=703).

Indicators	Immigrants (n=124)	Never leavers (n=445)	Returnees (n=134)	# Test statistics
Age (range: 23–53)				
Mean age (std)	42.2 (4.74)	38.2 (7.12)	38.6 (6.07)	17.77***
Median age	42.5	39.0	39.0	
Sex				
Male	65.3%	42.7%	61.2%	27.84***
Female	34.7%	57.3%	38.8%	
Marital Status				
Never married	14.5%	23.8%	21.6%	6.48
Currently married and living with spouse	76.6%	65.2%	69.4%	
Separated, divorced and widowed	8.9%	11.0%	9.0%	
Occupation				
Unskilled, service and agricultural	19.4%	7.9%	19.4%	76.39***
Clerical, factory, skilled and sales	29.0%	12.1%	11.9%	
Professional	14.5%	9.4%	4.5%	
Entrepreneur	20.2%	46.1%	35.8%	
Unemployed	11.3%	6.3%	6.7%	
Others	5.6%	18.2%	21.7%	
BMI - continuous				
Mean(std)	23.97 (3.04)	22.10 (3.31)	22.01(3.25)	17.27***
BMI in categories				
Underweight	3.4%	14.2%	15.7%	33.95***
Normal	58.1%	66.7%	65.6%	
Overweight	36.3%	16.4%	17.2%	
Obese	3.2%	2.7%	1.5%	
WHR -- continuous mean (std)				
	0.92(0.08)	0.83(0.07)	0.84(0.07)	72.04***
Having high WHR	77.0%	40.4%	34.6%	59.88***

Note:

*** significant at $p < 0.001$.

Test statistics: F statistics for continuous variables, and chi-square for categorical variables.

Table 2

Multivariate regression analysis on migration and weight status (N=703).

Outcome measures	Never-leavers (n=445) Beta (s.e.)	Returnees (n=134) Beta (s.e.)	Immigrants (n=124) Beta (s.e.)	R ²
BMI (continuous)				
Model 1: Never-migrants as reference		-0.25 (0.32)	1.40 ^{***} (0.35)	0.09
Model 2: Returnees as reference	0.25 (0.32)		1.65 ^{***} (0.41)	0.09
#WHR (continuous)				
Model 1: Never-migrants as reference		-0.004 (0.007)	0.066 ^{***} (0.007)	0.36
Model 2: Returnees as reference	0.004 (0.007)		0.07 ^{***} (0.008)	0.36
		Odds ratio/ CI	Odds ratio/ CI	
Being overweight/obese (yes)				
Model 1: Never-migrants as reference		0.86 (0.51-1.45)	2.16 ^{***} (1.34-3.47)	0.06
Model 2: Returnees as reference	1.16 (0.69-1.96)		2.50 ^{***} (1.38-4.54)	0.06
#Having high WHR (yes)				
Model 1: Never-migrants as reference		0.86 (0.56-1.31)	5.09 ^{***} (3.09-8.40)	0.14
Model 2: Returnees as reference	1.17 (0.77-1.78)		5.96 ^{***} (3.35-10.59)	0.14

Notes:

^{***} Significant at p <0.001.

Control variables include age, sex, marital status and occupation.

CI: 95% confidence interval.

Table 3
Multivariate regression models on acculturation and weight status among Vietnamese immigrants (N=124).

	Acculturation measures			Outcome variables					
	BMI Beta (s.e.)	P	WHR Beta (s.e.)	P	Being overweight/Obese Odds ratio (CI)	P	High WHR Odds ratio (CI)	P	
Model 1:									
Age at arrival	-0.12 (0.06) *	0.04	-0.003 (0.001) [^]	0.08	0.93 (0.85-1.02)	0.14	1.04 (0.93-1.15)	0.52	
Model 2:									
Length of residence	0.10 (0.06) [^]	0.09	0.001 (0.001)	0.44	1.04 (0.95-1.14)	0.35	0.96 (0.86-1.07)	0.46	
Model 3:									
LSFP	0.04 (0.09)	0.65	0.002 (0.002)	0.41	1.03 (0.90-1.18)	0.75	1.02 (0.88-1.19)	0.77	
Model 4:									
English proficiency	0.03 (0.13)	0.81	-0.002 (0.003)	0.44	0.90 (0.74-1.08)	0.25	0.76 (0.61-0.94) **	0.01	
Model 5:									
Vietnamese proficiency	-0.32 (0.19) [^]	0.09	-0.004 (0.005)	0.45	0.84 (0.65-1.10)	0.21	0.93 (0.68-1.28)	0.66	
Model 6:									
Bicultural orientation Being bilingual -- proficient in Both Vietnamese and English Others (as reference)	-0.88 (0.61)	0.15	-0.005 (0.02)	0.67	0.45 (0.18-1.15) [^]	0.09	0.64 (0.25-1.68)	0.64	

Notes:

[^] significant at p < 0.1 level.

* significant at p < 0.05 level.

** significant at p < 0.01 level.

LSFP (range 1-22): language, social and food preference scale, higher score indicates being more Americanized.

English proficiency scale (range 1-12) higher score indicates better English language skill.

Vietnamese proficiency scale (range 1-12): higher score indicates higher skill in Vietnamese language.

Control variables in the models include age, sex, marital status and occupational status. R squares in the models range from 0.09-0.16

CI: 95% confidence interval