IMMIGRATION AND GENERATIONAL TRENDS IN BODY MASS INDEX AND OBESITY IN THE UNITED STATES: RESULTS OF THE NATIONAL LATINO AND ASIAN-AMERICAN SURVEY (NLAAS), 2002-2003.

Lisa M. Bates, Dolores Acevedo-Garcia, Margarita Alegria, Nancy Krieger

ABSTRACT

Objectives. Estimates of body mass index (BMI)/obesity in the US rarely consider differences by nativity or country of origin. We examined patterns of BMI and obesity among a nationally representative sample of first, second, and third generation Latinos and Asian-Americans, overall and by subgroups.

Methods. Using the National Latino and Asian-American Survey (2002-2003) we generated nationally-represented estimates of mean BMI and obesity prevalence and explored changes in the distribution of BMI with generation in the US. Analyses tested the association between generation status and BMI, and examined whether this association varied by ethnicity, education, and gender.

Results. We found substantial heterogeneity in BMI/obesity by country of origin and an increase in BMI with generation, overall and among most subgroups. The data suggest different patterns for Latinos and Asian-Americans in the nature and degree of distributional changes in BMI with generation in the US.

Conclusions. Generation in the US is associated with increased BMI/obesity among Latinos and Asian-Americans. Aggregate estimates not accounting for nativity and country of origin may mask significant heterogeneity in the prevalence of obesity and patterns of distributional change, with implications for prevention strategies.

INTRODUCTION

Obesity is widely recognized as a significant and growing health problem in the United States.[1-9] Although racial/ethnic variation in obesity and obesity-related morbidity and mortality has been observed in several studies,[5, 10, 11] data on racial/ethnic patterns in obesity and body mass index (BMI) in the US are limited. For example, the NHANES, the primary data source for monitoring national prevalence trends in the US, only reports results for non-Hispanic Whites, non-Hispanic Blacks, and Mexican-Americans. In particular, there is a relative dearth of data on BMI and obesity among Asian-Americans, overall and by national-origin subgroup.[12-14] More scant are analyses that additionally take into account nativity; only a handful of studies report prevalence data and relative risks for indicators of adiposity by time in the US (e.g., nativity/generation and/or years since immigration).[12, 15-20] All but three of these investigations[15-16, 18] were based on the same data source (the National Health Interview Survey (NHIS)). These studies typically found that the prevalence of obesity was lower among first-generation immigrants compared to subsequent generations, and that length of US residence was associated with higher obesity among the foreign-born.

Examining patterns of BMI/obesity by generation is motivated by several considerations. As with other health outcomes, aggregate prevalence estimates may mask important heterogeneity. In particular, populations with high proportions of foreign-born (such as many groups of Asian origin/descent) may yield relatively low rates of morbidity and mortality that are largely driven by their composition of "healthy immigrants"[12] and that will likely change as the generational distribution of the population evolves. Moreover, immigrants and their US-born offspring are a rapidly increasing proportion of the total US population. Understanding the patterning of obesity by nativity is important for forecasting future trends in prevalence and related morbidity in the US and for identifying vulnerable populations for intervention. It can also elucidate etiologic processes related to changes in the physical, social, economic, and normative environment influencing patterns of obesity prevalence.

To improve understanding of the distribution of BMI and obesity by ethnicity and generation in the US, we accordingly used data from the National Latino and Asian-American Survey (NLAAS) to generate nationally-representative estimates of the mean BMI and prevalence of obesity for Latino and Asian-American adults overall and by subgroups defined by place of origin/ancestry, education (as a measure of socioeconomic position), and gender. We especially focused on how patterns of BMI distribution and obesity vary by generation among these groups, comparing first-generation immigrants (foreign-born) to those of the second- and third-generation.

DATA AND METHODS

Sample Design and data collection
The NLAAS, a population survey of psychiatric morbidity, is based on a stratified area probability sample of Latino and Asian-American adults recruited in 2002-2003 from the non-

institutionalized population of the United States. Eligibility criteria included age (18 years or older), ethnicity (Latino/Hispanic/Spanish or Asian ethnicity), and language (English, Spanish, Vietnamese, Chinese, or Tagalog). The sample design and data collection processes are described in full elsewhere.[21, 22] The sample was stratified by ethnicity/ancestry (Puerto Rican, Cuban, Mexican, other Latinos, Chinese, Filipino, Vietnamese, and other Asians). The survey first generated a nationally representative sample of all national origin groups independent of geographic residential patterns and then oversampled areas with a moderate to high density (≥ 5 %) of Latinos and Asian-Americans. Sample weights were used to correct for joint probabilities of selection. The final pooled, weighted sample is nationally representative and consists of a total of 4,649 respondents - 2,554 Latinos and 2,095 Asian-Americans. Data were collected by in-person interviews. Interviewers had bilingual proficiency and administered the survey using laptop computer-assisted software. Written informed consent was obtained in the respondent's preferred language. The overall response rate was 75.5% for the Latino sample and 65.6% for the Asian-American sample. The Internal Review Board Committees of Cambridge Health Alliance, the University of Washington, and the University of Michigan approved all procedures.

Measures
BMI was measured using self-reported height and weight converted to a metric scale (kg/m^2). For the categorical BMI outcome we followed the National Institutes of Health (NIH) classification guidelines[23] and defined obesity as BMI ≥ 30. For the primary exposure of interest (generation status) respondents were considered "first-generation" if they were not born in the mainland US, Alaska, or Hawaii; those born in Puerto Rico were classified as first-generation even though they were US citizens by birth. The "second-generation" refers to individuals born in the US who have at least one foreign-born parent. This categorization corresponds to the definition of second-generation most commonly used in the literature.[24-27] It has been argued that this definition inappropriately conflates the experiences of individuals with one foreign-born parent and those with two, despite evidence that they may diverge in demographic, socioeconomic or health outcomes.[28-29] However, our sample distribution does not allow us to examine these groups separately. "Third-generation" respondents were born in the US as were both of their parents (and possibly grandparents; this category actually refers to those who were third-generation or higher).

Data on ethnicity and country of origin/ancestry were based on self-report. Respondents were asked the number of years of schooling they had completed and we categorized the education variable as <12 years, 12 years, 13-15 years, and ≥16 years to correspond to the achievement of academic credentialing expected to be associated with socioeconomic position in the US.

Analyses
Data on self-reported weight and height were missing on 88 or 1.9% of the observations and these were excluded from all analyses. In addition, 5 observations had implausibly large BMI values (above 65) and these too were dropped. With the remaining 4556 observations we first examined key sample characteristics for Latinos and Asian-Americans separately, overall and by generation. We examined weighted mean BMI and prevalence of obesity/severe obesity (BMI $\geq$ 30) for Latinos and Asian-Americans overall and by subgroup, and compared these values across

generation in the US within each group. In these bivariate analyses we report p-values for group differences in mean BMI and obesity prevalence and for tests of trend across generation.

To further explore qualitatively changes in the entire distribution of BMI across immigrant generation, we graphically represent the distributions using Tukey mean-difference (m-d) plots.[30] Our analysis follows on recent applications of this method to compare changes in BMI distributions over time in the US and Canada.[31-32] We present m-d plots separately for Latinos and Asian-Americans, comparing within each the distributions of BMI for first- versus second-generation immigrants and for second- versus third-generation immigrants. The m-d plots were constructed by generating weighted BMI values corresponding to every even percentile level (2nd, 4th, 6th….98th) of each distribution. For each generation comparison, we then created a scatterplot of the mean of the two BMI values (*x*-axis) and the difference between the two BMI values (y-axis) at each percentile level. Although still a qualitative assessment, the m-d plots allow a visual estimation of both the nature and degree of shifts in the distribution of a continuous variable of interest.[31] If the y-axis values are constant at zero across all values of mean BMI, there is no difference between the two distributions. Departures from zero on the y-axis indicate the magnitude of difference between the two distributions at a given mean level, and the pattern of that departure suggests where in the distributions difference exists and the extent to which it is uniform across values of mean BMI. A fuller discussion of the method and interpretation of m-d plots is available in Flegal and Troiano, 2000.[31]

Finally, to determine if generation was significantly associated with BMI net of potential confounders, we fit multiple linear regression models of BMI on a dummy-coded categorical variable representing generation status, controlling for age, place of origin/ancestry, gender, and education. We choose to model BMI as a continuous outcome measure to avoid the statistical power limitations of a categorical analysis. We are also interested in understanding the potential effects of generation status on the entire BMI distribution (of which the mean is a summary measure), not just on one part of the distribution. In these analyses, we formally tested for interactions between generation and gender, education, and ethnicity. All statistical analyses were conducted using STATA.[33] To account for possible sample design effects, we used the *svyreg* procedure in STATA for variance estimation.[34] We used sample weights to adjust for probability of selection and non-response. The analyses reported here were approved by the Harvard School of Public Health Human Subjects Committee.

RESULTS

Table 1 presents basic descriptive characteristics of the sample, overall and by generation. Mexican-origin individuals represented the greatest proportion of Latinos and "other" Asians were the largest sub-group of Asian-Americans (multiple countries of origin were represented in this group, the largest being Japan, India, and South Korea). Educational attainment was higher among Asian-Americans compared to Latinos, overall and within each generation. Considerable heterogeneity in generation status was evident, especially among Asian-Americans. For example, 63% of the third-generation was "other" Asian compared to 33% of the first, and none of the third-generation was Vietnamese in origin compared to 16% of the first. Among Latinos, the place of origin/ancestry was more evenly distributed across generations, except for Cubans

5

who are very unlikely to be third-generation. The gender and age distributions were fairly uniform across generation for both Latinos and Asian-Americans.

Table 2 shows patterns in mean BMI and obesity prevalence by subgroups and across generation status. Looking first at the columns labeled "all" (combining individuals regardless of generational status), mean BMI and proportion obese (BMI ≥ 30) were considerably higher among Latinos than Asian-Americans overall and regardless of subgroup, but within each ethnic category there was significant heterogeneity. Among both Latinos and Asian-Americans, mean BMI was higher in men than women, but there were no statistically significant gender differences in obesity. Among Asian-Americans, obesity prevalence was significantly higher among persons with more education; among Latinos, the crude association was both non-significant and in the opposite direction. Significant tests for increases in BMI/obesity with generation were observed for Asian-Americans overall and Chinese and "Other" subgroups. Among Filipinos increases in obesity were borderline significant (p=.05) and among Vietnamese there was a statistically significant degrease in BMI/obesity between the first and second generation (and insufficient data to generate estimates for the 3rd generation). Increases in BMI/obesity with generation were also evident among Latinos, though less statistically significant. The one exception was among Puerto Ricans, where we observed a statistically significant *decrease* in obesity with generation.

The m-d plots in Figure 1 provide information about changes in the full distribution of BMI with generation. Among Latinos, the plots indicate that between the first- and second-generations part but not all of the distribution shifted; in the approximate range of "overweight" or less (mean BMI < 28) the *y*-axis values were close to zero (or even below), indicating no real increase between generations at this level. However, at the higher end of the distribution (above mean BMI 30) there was a gradually increasing upward shift in the second-generation compared to the first. In the third-generation (compared to the second) this upward shift began at a lower point in the distribution (at about mean BMI 25), and remained fairly constant until the most extreme upper bound of the distribution.

In contrast, among Asian-Americans, an upward shift occurred in the second-generation at every level of the distribution. The difference was slight (< 1 unit BMI) below a mean BMI of 27, but then large and progressively greater at the upper end of the distribution (especially the top 10th percentile). Between the second- and third-generations the full distribution of BMI also shifted upward, but the skewness did not increase constantly: at the low end of the distribution differences were increasingly large and then, above a mean BMI of 28, increasingly small. Therefore, among Asian-Americans there is both a shift in the entire distribution of BMI and upward skew with increasing generation.

Table 3 presents the results of multiple regression analyses of the association between generation and BMI. The analyses mostly confirmed the bivariate results, showing statistically significant increases in BMI with generation for both Latinos and Asian-Americans overall and most ethnic-specific gender and education subgroups. Among both Latinos and Asian-Americans there was very little evidence of confounding of the association between generation and BMI by education, age, or gender. However, the crude (positive) association between generation and BMI among

Asian-Americans was strongly confounded by country of origin/ancestry (results not shown). We did not observe any statistically significant interactions between generation and ethnicity, gender, or education. A statistically significant difference in BMI between 2nd and 3rd generation was evident only among Asian-American men (p = .01) and Asian-Americans with low education (p = .03).

DISCUSSION

We have found in a nationally representative sample of Latinos and Asian-Americans in the US significant heterogeneity in estimates of BMI/obesity and an increase in mean BMI with immigrant generation among most subgroups considered. To our knowledge, these are the first analyses of patterns in adult BMI/obesity by generation in the US allowing for comparisons of multiple subgroups and distinguishing between the second- and third-generation. Together, these findings underscore the importance of data on adiposity that is disaggregated by ethnic subgroup and generational status.

Of note, the estimates of obesity among Asian-Americans we observed were on average lower than the US population as a whole, but the aggregate estimates masked the degree to which obesity was increasing dramatically with generation and, among certain subgroups, such as Filipinos, reaching levels in the third-generation comparable to the general US population. These findings of considerable heterogeneity among Asians by country of origin and nativity are consistent with results reported elsewhere.[35] The prevalence of obesity we observed among Latinos overall and by subgroup was comparable to or higher than in the general US population. The atypical downward trend in crude obesity prevalence with generation among Puerto Ricans most likely reflects levels of obesity in Puerto Rico that are comparable to those on the mainland US[36] and the fact that the "healthy immigrant effect" appears to not apply to immigrants of Puerto Rican origin,[37] possibly due to processes of negative selection among Puerto Rican immigrants to the US.[38] The NLAAS was not designed (and therefore not powered) to formally test for subgroup differences in the association between generation and BMI. We presented results stratified by subgroup to the extent possible to allow for qualitative assessment of variation and consistency in BMI patterns. Future studies may benefit from larger samples designed to be able to formally test for differences in these patterns.

Our results are consistent with other studies based on data from the NHIS showing nativity differences in BMI/obesity among Asians[12] and Latinos,[17] but suggest that the trends toward increasing BMI/obesity with generation may continue into at least the third-generation, particularly among Asian-Americans. Khan et al (1997)[15] also found statistically significant differences in BMI in the second- and third-generations relative to the first among Mexican Americans in the US. Although the observed differences between third and second-generation were only statistically significant for Asian-American men and Asian-Americans with low education, the upward trend was fairly consistent across all subgroups. Our findings are comparable to those of Popkin and Udry (1998)[16] who reported increased adiposity with generation among a sample of adolescent (age 15-22) Hispanics and Asian-Americans, though they observed much smaller, non-statistically significant differences between the second- and third-generations. Popkin and Udry (1998)[16] also found that differences between first and

subsequent generations appear more pronounced overall among Asian-Americans compared to Hispanics.

Among Asian-Americans we found that with each generation there was both an upward shift in the entire BMI distribution as well as increasing upward skew. This pattern is consistent with the argument of Geoffrey Rose that changes in the tails of a distribution of a given characteristic, such as BMI or blood pressure, cannot be divorced from what is happening to the entire distribution.[39] Among Latinos the distribution is increasingly skewed upward with generation, but that the percentage in the "normal/underweight" categories (BM<25) remains fairly constant. The nature of changes in the distribution of BMI has potential implications for strategies to both understand the etiology of obesity and to develop interventions to prevent or reduce it. The part of the distribution changes that represent an entire upward shift indicates influences on levels of obesity that affect the full population (suggesting the need for a "population" approach), and the part driven by increased dispersion of the curves (the spread of the upper tail) suggests differential susceptibility and/or exposure to risk factors for obesity (indicating the need for more of a "high risk" approach).

There are important limitations to the present study. Most significant is the reliance on self-reported weight and height data. Although self-report is considered an acceptable method of BMI ascertainment and is widely used, systematic biases (e.g., underestimating weight and overestimating height) have been observed[40-46] Factors associated with biased reporting include age, gender, mode of interview, education, race/ethnicity, and actual height or weight status. We adjust for all but the last of these factors in regression analyses, however, the validity of self-reported anthropometric measures by immigrant generation and national-origin subgroup is largely unknown.[12] Accuracy of self-report weight and height could vary by access to health care as well as the salience and cultural understanding of these concepts.[47] However, one of the few systematic investigations of this question, comparing immigrant to non-immigrant Mexican Americans, concludes that self-report is accurate for both, except among those who are underweight.[48] Findings elsewhere that self-report data generated greater underestimates of overweight and obesity among Mexican American men and women compared to non-Hispanic blacks and whites[49] suggests that our prevalence estimates are, if anything, conservative. Although we found significant differences in 3rd generation Asian-Americans compared to earlier generations, the estimates for this group are imprecise due to the sample size limitations. Finally, we could not examine fully and in adjusted analyses the generation differences in BMI disaggregated by place of origin/ancestry due to sample size constraints. For example, the aggregate adjusted estimate of the association between generation and BMI among Latinos may be masking a decrease and/or lack of change among Puerto Ricans and Cubans. The high percentage of Asian-Americans with unspecified national origins also limits our interpretation of the data. Our results highlight the potential importance of adjusting for country of origin/ancestry in such aggregate estimates, especially among a sample of Asian-Americans, given sizeable national origin differences in nativity and BMI.

Nevertheless, our findings of increasing BMI and obesity with generation among immigrants to the US support a growing consensus regarding the important role of social and physical environmental influences on body weight.[50-54] As with secular trends in obesity in the US, the

increases in BMI across generation are occurring in too short of a time span to be largely driven by genetic factors alone. Hypotheses to account for the intergenerational trends include: (1) exposure to types of food supply, marketing, pricing, and physical infrastructure (e.g., building design and transportation) associated with increased BMI and obesity,[50-54] and (2) within this context, the process of "acculturation" (whereby immigrants are posited to adopt US norms and practices with respect to diet and physical activity).[16-19] An important additional question regarding the role of environmental influences on obesity is the timing of the exposure over the life course. Early life obesity is associated with adult obesity[55] but overall the unique or synergistic influences of specific childhood exposures on later life obesity are not well understood.[56] Our results showing differences in BMI between first- and second-generation immigrants (particularly among Latinos) suggest that significant childhood exposure to the US environment may influence adult BMI, but our analyses cannot disentangle the effect of any specific period of childhood exposure from total cumulative exposure. Future studies should examine the effects of age at arrival to the US on BMI among the foreign-born.

Our findings suggesting possible differences in BMI between second- and third-generation immigrants (particularly among Asian-Americans) also raise questions regarding parental influences on obesity. Intergenerational factors, including parental BMI, have been shown to influence childhood adiposity.[55-57] Since parental nativity distinguishes second- and third-generation immigrants, a focus on the influence of parental characteristics may help explain these patterns. In a study of generational effects on current smoking among immigrants, Acevedo-Garcia et al (2005)[29] disaggregated the second-generation to account for differences by number of foreign-born parents. Their results suggest the relevant distinction is between having two foreign-born parents versus one or two US-born parents; they observed no difference in the odds of smoking associated with having one versus two US-born parents, but a reduced odds among those with two foreign-born parents.

In conclusion, the finding of sizeable increases in BMI/obesity with generation, particularly among Asian-Americans, indicates that ongoing changes in the demographic distribution of immigrant populations in the US may bring with them significant increases in the overall prevalence of obesity. For certain groups they may also be associated with disproportionate increases in morbidity. For example, there is evidence of differential susceptibility to weight-related morbidity among Asians; Asian populations appear to be at higher risk for outcomes such as diabetes at a given level of adiposity and regarding only the standard risk category of "obese" as clinically significant may not be appropriate for this group.[58] We found that among Asian-Americans, generation is associated with a considerable upward shift in BMI levels well below this standard "high risk" threshold. Understanding dynamics by generation is increasingly important as the US-born continues to grow as a proportion of Latino and Asian-American populations; between 2000-2020 it is estimated that the second-generation will account for 47% of the growth of the Latino population in the US, compared to 25% between 1970 and 2000.[22] The net implication is that efforts to monitor trends in obesity should as much as possible disaggregate data by nativity, as well as by country of origin/ancestry, to avoid masking important sources of heterogeneity within ethnic populations. Prevention strategies seeking to better understand how influences on obesity may be ameliorated will need to consider the ways in which immigrants and their offspring are both uniformly and variably at risk.

REFERENCES

1. Fontaine K, Bartlett S. Estimating health-related quality of life in obese individuals. *Dis Manage Health Outcomes.* 1998;3:61-70.

2. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282:1523-1529.

3. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. *JAMA.* 1999;282:1530-1538.

4. Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *JAMA.* 2005;293:1861-1867.

5. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA.* 2003;289:76-79.

6. Kuczmarski RJ, Flegal KM, Campbell SM., Johnson CL. Increasing prevalence of overweight among US adults: the National Health and Nutrition Examination Surveys, 1960 to 1991. *JAMA.* 1994;272:205-211.

7. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999-2000. *JAMA.* 2002;288:1723-1727.

8. Ogden CL, Carroll MD, Curtin LR, McDowell, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA.* 2006;295:1549-1555.

9. US Department of Health and Human Services (USDHHS). The Surgeon General's call to action to prevent and decrease overweight and obesity. Rockville, MD: US Department of Health and Human Services, Public Health Office, Office of the Surgeon General; 2001.

10. Vega WA, Amaro H. Latino outlook: Good health, uncertain prognosis. *Annu Rev Public Health.* 1994;15:39–67.

11. Sorlie PD, Backlund E, Johnson NJ, Rogot E. Mortality by Hispanic status in the United States. *JAMA.* 1993;270:2464–2468.

12. Lauderdale DS, Rathouz PJ. Body mass index in a US national sample of Asian-Americans: effects of nativity, years since immigration and socioeconomic status. *Int J Obes (Lond)*, 2000;24:1188-1194.

13. McNeely MJ, Boyko EJ. Type 2 diabetes prevalence in Asian-Americans. *Diabetes Care.* 2004;27:66-69.

14. Crawford PB, Story M, Wang MC, Ritchie LD, Sabry ZI. Ethnic issues in the epidemiology of childhood obesity. *Pediatr Clin North Am*. 2001;48:855-878.

15. Khan LK, Sobal J, Martorell R. Acculturation, socioeconomic status, and obesity in Mexican Americans, Cuban Americans, and Puerto Ricans. *Int J Obes Relat Metab Disord*. 1997;21:91-96.

16. Popkin BM, Udry JR. Adolescent obesity increases significantly in second and third-generation US immigrants: The National Longitudinal Study of Adolescent Health. *J Nutr*. 1998;128:701-706.

17. Goel MS, McCarthy EP, Phillips RS, Wee CC. Obesity among US immigrant subgroups by duration of residence. *JAMA*. 2004;292:2860-2867.

18. Kaplan MS, Huguet N, Newsom JT, McFarland BH. The association between length of residence and obesity among Hispanic immigrants. *Am J Prev Med*. 2004;27:323-326.

19. Himmelgreen DA, Perez-Escamilla R, Martinez D, et al. The longer you stay, the bigger you get: Length of time and language use in the US are associated with obesity in Puerto Rican Women. *Am J Phys Anthropol*. 2004;125:90-96.

20. Singh GK, Siahpush M. Ethnic-immigrant differentials in health behaviors, morbidity, and cause-specific mortality in the United States: An analysis of two national data bases. *Hum Biol*. 2002;74:83-109.

21. Heeringa SG, Wagner J, Torres M, Duan N, Adams T, Berglund P. Sample designs and sampling methods for the Collaborative Psychiatric Epidemiology Studies (CPES). *Int J Methods Psychiatr Res*. 2004;13:221-240.

22. Pennell BE, Bowers A, et al. The Development and Implementation of the National Comorbidity Survey Replication, the National Survey of American Life, and the National Latino and Asian-American Survey. *Int J Methods Psychiatr Res*. 2004;13:241-269.

23. National Institutes of Health (NIH). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. *Obes Res*. 1998;6(Suppl. 2):51S-209S.

24. Suro R, Passel JS. *The rise of the second-generation: changing patterns in Hispanic growth*. Washington, DC: Pew Hispanic Center; 2003.

25. Portes A, Rumbaut R. *Legacies : The Story of the Immigrant Second-generation*. Berkeley, CA: University of California Press; 2001.

11

26. Borjas GJ. *Heaven's Door: Immigration Policy and the American Economy*. Princeton, NJ: Princeton University Press; 1999.

27. Rumbaut RG. Ages, Life Stages, and Generational Cohorts: Decomposing the Immigrant First and Second Generations in the United States. *Int Migr.* 2004;38:1160-1205.

28. Ramakrishnan SK. Second-generation immigrants? The "2.5 generation" in the United States. *Soc Sci Quart.* 2004;85:380-399.

29. Acevedo-Garcia D, Pan J, Jun HJ, Osypuk TL, Emmons KM. The effect of immigrant generation on smoking. *Soc Sci Med.*. 2005;61:1223-1242.

30. Cleveland WS. *Visualizing Data*. Summit NJ: Hobart Press; 1993.

31. Flegal KM, Troiano RP. Changes in the distribution of body mass index of adults and children in the US population. *Int J Obes (Lond)*. 2000;24:807-818.

32. Katzmarzyk PT. The Canadian obesity epidemic: An historical perspective. *Obes Res.* 2002;10:666-674.

33. StataCorp. *Stata Reference Manual: Release 8*. College Station, TX: Stata Corporation;2003a.

34. StataCorp. *Stata User's Guide: Release 8*. College Station, TX: Stata Corporation;2003b.

35. Gomez SL, Kelsey JL, Glaser SL, Less MM, Sidney S. Immigration and Acculturation in relation to health and health-related risk factors among specific Asian subgroups in a health maintenance organization. *AJPH*. 2004;94:1977-1984.

36. Balluz L, Ahluwalia IB, Murphy W, Mokdad A, Giles W, Harris VB. Surveillance for certain health behaviors among selected local areas – United States, Behavioral Risk Factor Surveillance System, 2002. *MMWR Surveill Summ.* 2004;23:1-100.

37. Palloni A, Arias E. Paradox lost: Explaining the Hispanic adult mortality advantage. *Demography*. 2004;41:385-415.

38. Enchautegui ME. Selectivity patterns in Puerto Rican migration. Paper presented at: Population Association of America Annual Meeting; March 31-April 2, 2005; Philadelphia, PA.

39. Rose G. Sick individuals and sick populations. *Int J Epidemiol.* 1985;14:32-38.

40. Palta M, Prineas RJ, Berman R, Hannan P. Comparison of self-reported and measured height and weight. *Am J Epidemiol.* 1982;115:223-230.

41. Stewart AW, Jackson RT, Ford MA, Beaglehole R. Under-estimation of relative weight by use of self-reported height and weight. *Am J Epidemiol.* 1987;125:122-126.

42. Kuczmarski MF, Kuczmarski RJ, Najjar M. Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National health and Nutrition Examination Survey 1988-1994. *J Am Diet Assoc.* 2001;101:28-34.

43. Engstrom JL, Paterson SA, Doherty A, Trabulsi M, Speer KL. Accuracy of self-reported height and weight in women: an integrative review of the literature. *J Midwifery Women's Health.* 2003;48:338-345.

44. Villanueva EV. The validity of self-reported weight in US adults: a population based cross-sectional study. *BMC Public Health.* 2001;1:11.

45. Ezzati M, Martin H, Skjold S, Vander Hoorn S, Murray CJ. Trends in national and state-level obesity in the USA after correction for self-report bias: analysis of health surveys. *J R Soc Med.* 2006;99:250-257.

46. Johnson TP, O'Rourke D, Chavez N, Sudman S, Warnecke R, Lacey L. Social cognition and response to survey questions among culturally diverse populations. In: Lyberg L, Biemer P, Collins M, de Leeuw E, Dipp C, Schwarz N, Trewin D eds. *Survey Measurement and Process Quality.* New York, NY: Wiley; 1997:87-114.

47. Lee SK. Validity of self-reported weight and height: Comparison between immigrant and non-immigrant Mexican Americans in NHANES III. *J Immig Health.* 2005;7:127-131.

48. Rowland ML. Self-reported weight and height. *Am J Clin Nutr.* 1990;52:1125-1133.

49. Gillum RF, Sempos CT. Ethnic variation in validity of classification of overweight and obesity using self-reported weight and height in American women and men: the Third National Health and Nutrition Examination Survey. *Nutr J.* 2005:4:27.

50. Astrup A, Hill JO, Rössner S. The cause of obesity: are we barking up the wrong tree? (Editorial). *Obes Rev..* 2004;5:125-127.

51. Jeffery RW, Utter J. The changing environment and population obesity in the United States. *Obes Res.* 2003;11:12S-22S.

52. Jeffery RW. Public health strategies for obesity treatment and prevention. *Am J Health Behav.* 2001;25:252-259.

53. Egger G, Swinburn B. An "ecological" approach to the obesity pandemic. *BMJ.* 1997;315:477-480.

54. Swinburn B, Egger G. Preventive strategies against weight gain and obesity. *Obes Rev.* 2002;3:289-301.

55. Gillman M. A life course approach to obesity. In: Kuh D, Ben-Shlomo Y, eds. *A Life Course Approach to Chronic Disease Epidemiology*. 2nd ed. Oxford, U.K.: Oxford University Press; 2004:189-217.

56. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes (Lond)*. 1999;23 (Suppl. 8):S1-107.

57. Yajnik, CS. The lifecycle effects of nutrition and body size on adult adiposity, diabetes and cardiovascular disease. *Obes Rev.* 2002;2:217-224.

58. World Health Organization (WHO) Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363:157-163.

Table 1. Characteristics of Sample, Overall and by Generation Status; Weighted Percentages and Means: National Latino and Asian American Survey (NLAAS), (2002-2003).

	All		Generation Status 1st		2nd		3rd	
	N*	%	N*	%	N*	%	N*	%
Latinos	2480	73.0	1571	66.9	515	80.8	390	85.9
Asian Americans	2076	27.0	1629	33.1	268	19.1	179	14.1
<u>Latinos</u>								
Place of origin/ancestry								
Puerto Rico	490	10.4	214	8.1	163	16.2	113	10.7
Cuba	570	4.8	494	7.1	72	3.0	4	0.2
Mexico	820	55.6	450	53.7	188	57.7	182	58.7
Other	600	29.2	413	31.1	92	23.1	95	30.4
Women	1363	47.2	856	46.6	287	49.2	220	46.6
Men	1117	52.8	715	53.4	228	50.8	174	53.4
Education								
<12 years	942	43.3	698	53.8	130	29.8	114	28.2
12 years	622	25.0	354	20.4	135	28.2	133	34.4
13-15 years	560	21.4	295	16.6	163	28.9	102	26.8
16+ years	356	10.3	224	9.2	87	13.2	45	10.5
Age, mean (sd)	2480	38 (14.7)	1571	39.1 (15.8)	515	36.4 (14.4)	394	36.6 (13.4)
<u>Asian Americans</u>								
Place of origin/ancestry								
Vietnam	516	12.9	498	16.2	18	2.9	0	--
Philippines	500	21.4	345	19.6	112	35.6	43	15.6
China	597	28.9	474	30.9	72	23.0	51	21.3
Other	463	36.8	312	33.4	66	38.5	85	63.1
Women	1081	52.1	860	51.1	136	47.2	85	43.4
Men	995	47.9	769	48.9	132	52.8	94	56.6
Education								
<12 years	312	15.0	296	20.6	12	3.4	4	0.9
12 years	369	17.8	272	16.4	53	25.5	44	23.7
13-15 years	523	25.2	368	22.1	89	30.3	66	41.6
16+ years	871	42.0	692	41.0	114	40.8	65	33.8
Age, mean (sd)	2076	41.3 (14.7)	1629	42.3 (14.2)	268	35.2 (17.0)	179	37.9 (13.3)

*Unweighted

Table 2. Mean BMI and Percent Obese (BMI 30+) Overall and by Generation Status for Latinos and Asian Americans and Ethnic-Specific Subgroups: National Latino and Asian American Survey (NLAAS), 2002-2003.

	Mean BMI (se)				Percent obese (95% CI)			
	All †	1st Gen	2nd Gen	3rd Gen ‡	All †	1st Gen	2nd Gen	3rd Gen ‡
Latinos	28.0 (0.2)	27.6 (0.2)	28.2 (0.3)	28.8 (0.4)	29.1 (26.7, 31.4)	25.4 (23.2, 27.7)	32.3 (26.4, 38.2)	35.7 (29.3, 42.2) *
Asians	24.2 (0.1) ***	23.8 (0.2)	24.9 (0.3)	26.6 (0.6) ***	9.4 (7.9, 11.0) ***	6.9 (5.1, 8.7)	13.5 (9.2, 17.8)	24.2 (16.4, 32.0) ***
Latinos								
Puerto Rican	27.8 (0.3)	28.3 (0.5)	27.7 (0.4)	26.8 (0.7)	29.8 (23.8, 35.7)	34.9 (27.8, 42.0)	26.6 (17.1, 36.0)	24.1 (16.7, 31.4) *
Cuban	27.3 (0.2)	27.3 (0.2)	27.0 (0.6)	24.8 (2.2)	21.7 (18.1, 25.3)	21.7 (17.7, 25.7)	21.8 (11.2, 32.3)	18.5 (-19.0, 56.0)
Mexican	28.5 (0.2)	28.1 (0.4)	28.7 (0.5)	29.2 (0.6)	32.5 (28.5, 36.5)	28.5 (24.5, 32.5)	37.3 (29.6, 45.0)	37.7 (28.4, 46.8)
Other	27.2 (0.2) ***	26.6 (0.2)	27.2 (0.7)	28.9 (0.5) ***	23.5 (19.5, 27.5) ***	18.5 (14.2, 22.9)	25.1 (13.4, 36.8)	36.2 (26.5, 45.9) **
Women	27.6 (0.2)	27.2 (0.3)	28.0 (0.4)	28.2 (0.4)	28.3 (25.2, 31.4)	26.5 (23.2, 29.9)	29.1 (21.7, 36.5)	32.3 (23.9, 40.8)
Men	28.3 (0.2) **	27.9 (0.3)	28.4 (0.5)	29.4 (0.6)	29.7 (26.5, 32.9)	24.5 (21.0, 27.9)	35.3 (27.6, 43.1)	38.7 (32.2, 45.2) **
Education								
≤12 yrs	28.0 (0.1)	27.8 (0.3)	28.0 (0.5)	28.6 (0.5)	30.4 (27.4, 33.5)	27.4 (24.7, 30.2)	33.8 (25.9, 41.7)	37.0 (29.7, 44.2)
13+ yrs	27.8 (0.3)	26.8 (0.3)	28.4 (0.4)	29.1 (0.5) ***	26.1 (21.9, 30.3)	19.7 (14.9, 24.5)	30.2 (22.3, 38.0)	33.6 (24.8, 42.5) **
Asians								
Vietnamese	22.4 (0.2)	22.5 (0.2)	20.3 (0.6)	N/A (n/a) **	2.5 (0.5, 4.5)	2.6 (0.5, 4.6)	0.0 (--)	N/A (n/a) *
Filipino	25.8 (0.2)	25.4 (0.3)	26.4 (0.6)	27.3 (1.3)	17.2 (13.2, 21.2)	13.6 (8.6, 18.6)	23.5 (15.2, 31.8)	33.3 (9.7, 56.9)
Chinese	23.1 (0.2)	22.7 (0.2)	23.7 (0.4)	26.9 (0.8) ***	4.3 (3.2, 5.4)	2.6 (1.2, 4.0)	6.0 (0.6, 11.4)	22.1 (15.1, 29.1) ***
Other	25.0 (0.2) ***	24.6 (0.2)	24.6 (0.8)	26.3 (0.7)	11.3 (7.4, 15.3) ***	9.1 (5.4, 12.7)	9.7 (3.4, 15.9)	22.7 (12.9, 32.5) **
Women	23.6 (0.2)	23.2 (0.2)	24.2 (0.5)	25.4 (1.1) *	9.7 (7.1, 12.4)	7.5 (4.9, 10.1)	13.3 (9.1, 17.4)	25.0 (7.6, 42.4) *
Men	25.0 (0.2) ***	24.5 (0.2)	25.6 (0.4)	27.6 (0.6) ***	9.1 (6.4, 11.8)	6.2 (4.5, 8.0)	13.7 (7.4, 20.0)	23.5 (10.2, 36.8) ***
Education								
≤12 yrs	24.0 (0.2)	23.5 (0.2)	24.9 (0.5)	27.6 (0.9) ***	6.9 (3.8, 10.0)	4.4 (1.5, 7.3)	10.0 (1.7, 18.3)	31.1 (16.4, 45.9) ***
13+ yrs	24.4 (0.2)	24.0 (0.2)	24.9 (0.4)	26.3 (0.9) **	10.6 (9.1, 12.1) *	8.2 (6.4, 10.1)	14.8 (11.7, 18.0)	21.9 (11.6, 32.3) **

*p<.05   **p<.01   ***p<.001

† p-values report significance levels for tests of group differences in mean BMI and obesity prevalence

‡ p-values report significance levels for tests of trend in mean BMI and obesity prevalence across generation status for each subgroup

Table 3. Multiple Linear Regression of BMI on Generation Status Among Latinos and Asian Americans and Ethnic-Specific Subgroups: National Latino and Asian American Survey (NLAAS), 2002-2003

Strata	N	Generation Status		
		1st beta (95% CI)	**2nd** beta (95% CI)	**3rd** beta (95% CI)
Latino - all[a]	**2480**	(reference)	1.25 (0.60, 1.90) ***	1.56 (0.58, 2.54) **
Women[b]	**1363**	(reference)	1.38 (0.40, 2.37) **	1.33 (0.25, 2.41) *
Men[b]	**1117**	(reference)	1.14 (-0.11, 2.38)	1.76 (0.23, 3.30) *
≤12 yrs education[c]	**1564**	(reference)	0.71 (-0.23, 1.65)	1.08 (-0.24, 2.40)
13+ yrs education[c]	**916**	(reference)	1.92 (0.92, 2.93) ***	2.18 (1.01, 3.35) **
Asian - all[a]	**2075**	(reference)	1.07 (0.49, 1.65) **	2.20 (0.84, 3.56) **
Women[b]	**1081**	(reference)	1.14 (0.18, 2.11) *	1.54 (-0.57, 3.66)
Men[b]	**994**	(reference)	1.03 (0.29, 1.77) **	2.86 (1.69, 4.04) ***
≤12 yrs education[c]	**681**	(reference)	1.22 (0.00, 2.43)	3.25 (1.61, 4.89) ***
13+ yrs education[c]	**1394**	(reference)	1.10 (0.25, 1.94) *	1.97 (0.18, 3.75) *

[a] Models control for age, place of origin/ancestry, education, and gender
[b] Models control for age, place of origin/ancestry, and education
[c] Models control for age, place of origin/ancestry, and gender
*p<.05
**p<.01
***p<.001

Figure 1. Tukey Mean-Difference Plots Comparing Distributions of BMI by Generation Among Latinos and Asian Americans: National Latino and Asian American Survey (NLAAS), 2002-2003.