Published in final edited form as:
Soc Sci Med. 2010 June ; 70(12): 1997–2005. doi:10.1016/j.socscimed.2010.02.026.

Immigrant generation and physical activity among Mexican, Chinese & Filipino adults in the U.S

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Abstract

Migrant studies of physical activity (PA) can provide insight into the prevention of chronic disease. It is unclear, however, whether PA increases or decreases the longer migrants live in their host country. In the US, studies on immigrants' length of residence in the US and PA are inconclusive and many studies do not adequately consider the role of socioeconomic status (SES). Using California data, we examine relationships between immigrant generation and physical activity (PA) among Mexican, Chinese and Filipino adults, who represent the three largest immigrant groups in the US, and the extent to which the relationships are confounded by SES. Data from the 2000 US Census was linked with data on adults 18 years and older from the 2005 California Health Interview Survey. PA was measured in three different domains: leisure time (LTPA), non-leisure time (NLTPA) and any PA. Logistic regression was used to examine whether a wide range of SES factors, measured at the respondent and neighborhood levels, influenced the relationship between immigrant generation and PA in all domains and in different ethnic origin groups.

Generation was significantly associated with LTPA among Mexican and Chinese adults and with NLTPA among all 3 ethnic origin groups; however the nature of the relationships varied. After adjusting for individual and neighborhood SES factors, a positive association between generation and LTPA remained among Mexican adults, and negative association between generation and NLTPA remained among Chinese and Filipino adults. These results underscore the importance of comparative studies of immigrant generation and PA and consideration of SES factors to identify pathways linking generation to PA. In the context of increasing rates of chronic disease, the study of transitions in PA among immigrants will continue to be critical to promoting the public health of diverse populations in countries such as the US.

Keywords

Acculturation; Assimilation; Hispanic-Americans; Asian-Americans; Mexican-Americans; Chinese-Americans; Filipino-Americans; Physical activity; USA; Socioeconomic status (SES)

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Introduction

Globally, rapid changes in exposures in migrant populations, relative to the native populations in their host countries, provide insight into the epidemiology and prevention of chronic disease. Depending on characteristics of the migrant population and the social and cultural environment in the host country, the chronic disease risk profile of migrants may worsen or improve the longer theylive in their newhost country (Dawson, Sundquist, & Johansson, 2005; Salmond, Prior, & Wessen, 1989; Williams, 1993). In the US, there is evidence that the risk of diabetes, hypertension and cancer among selected immigrant populations increases with greater time in the US (Ahmed et al., 2009; Moran et al., 2007; West et al., 2002; Ziegler et al., 1993). To better understand the factors that might be responsible for the increasing risk of chronic disease with time among US immigrants, it is necessary to examine how the underlying determinants change following migration.

Understanding determinants of morbidity among immigrants in the US is a public health concern for its general population given demographic trends. Between 1990 and 2000, the foreign-born population in the US increased from 19.8 million to 31.1 million, an increase of 57%, compared with an increase of 9.3% for the native population (Malone, Baluja, Costanzo, & Davis, 2003). It is projected that 87% of the population growth between 2005 and 2050 will be driven by immigrants and their US-born children (Passel & Cohn, 2008), warranting an epidemiological perspective that centers on the migrant experience and behavioral changes that follow migration.

Physical activity (PA) is an important determinant of morbidity from cardiovascular disease, diabetes, and cancer (DHHS, 1996, 2000) and it is also a modifiable behavior. This study examines how physical activity changes across generations among adults from Mexico, China and the Philippines, who represent the three largest immigrant groups in the US constituting 29.5%, 4.9% and 4.4% of the foreign born respectively (Malone et al., 2003). Determinants of PA among these groups remain under-explored and according to studies of Latino and Asian populations, it is unclear whether PA levels increase or decrease with greater time in the US.

Length of residence in the US and physical activity

Studies in the aggregate Latino adult population provide evidence of a positive association between length of residence in the US and the likelihood or level of leisure-time physical activity (LTPA) (Abraido-Lanza, Chao, & Florez, 2005; Cantero, Richardson, Baezconde-Garbanati, & Marks, 1999; Crespo, Smit, Carter-Pokras, & Andersen, 2001). These results are consistent with studies of language acculturation measures and LTPA (Berrigan, Dodd, Troiano, Reeve, & Ballard-Barbash, 2006; Perez-Stable, Marin, & Marin, 1994). Although studies that examine non-leisure time PA (NLTPA), defined as occupational, transportation-related, and household-related PA, have not used time measures, they generally find a negative association with language acculturation (Berrigan et al., 2006; Ham, Yore, Kruger, Heath, & Moeti, 2007; Slattery et al., 2006; Wolin, Colditz, Stoddard, Emmons, & Sorensen, 2006).

Studies of Asians also have mixed findings. One population-based study examining years in the US and LTPA among Asians as an aggregate group found a positive association in stratified analyses of men and women, a result consistent with a study among Korean adults using a multi-dimensional measure of acculturation (Kandula & Lauderdale, 2005; Lee, Sobal, & Frongillo, 2000). In contrast, a third study (Huang et al., 1996) found a negative association between US nativity and levels of total PA among Japanese men in Hawaii.

Based on the studies reviewed, a pattern emerges: length of time in the US or acculturation is positively associated with LTPA and negatively associated with NLTPA. Yet, these studies are not without limitations. First, studies of Latino populations do not consider potential difference by ethnic origin. Those of Asians have not included Chinese and Filipino populations, the two largest Asian ethnic groups in the US. Third, it is difficult to ascertain the relationship between length of time in the US and combined levels of LTPA and NLTPA. Consideration of both types of PA is important because each type of PA may be influenced by a different set of factors resulting in potential differences in rates across ethnic groups (Berrigan et al., 2006; Evenson, Rosamond, Cai, Pereira, & Ainsworth, 2003). On the issue of disease prevention, we are concerned with the cumulative amount of PA, regardless of type, that produces the maximum health benefits (Haskell et al., 2007). Moreover, many of the studies do not adequately consider the role of socioeconomic status (SES) and in particular, whether it confounds the association between time in the US or acculturation measures and PA (Hunt, Schneider, & Comer, 2004).

Theoretical framework: segmented assimilation

This study is informed by segmented assimilation theory, which encompasses both dimensions of acculturation and SES. Segmented assimilation theory views immigrant generation as a central variable conceptualized broadly as a time dimension reflecting increasing exposure to US social and cultural norms (Portes, 1996). More specifically, this theory emerged from the extensive study of the children of recent immigrants from Asia and Latin America, known as the “new second generation” (Portes, 1996). While classical theories of assimilation have argued that the length of residence in the US leads to the progressive narrowing of socioeconomic differentials with the native-born population, and gradual adoption of the traits of the host culture with a loss of those from their home country (Alba & Nee, 1997; Gordon, 1964), segmented assimilation proposes a less uni-directional path. Instead, it proposes diverse paths of acculturation and social mobility from one generation to the next.

The diverse paths experienced by US immigrants are dictated by a complex set of factors, including the presence or absence of an ethnic enclave, political context in the US at the time of migration and prejudices and values of the receiving community, particularly receptivity of or discrimination against the immigrant group (Portes, 1996). Alternative paths to classical assimilation may resemble selective assimilation, characterized by economic advancement with deliberate preservation of the immigrant community’s values and traditions; or downward assimilation, a process that leads to greater identification with a minority subculture and permanent poverty (Portes & Zhou, 1993). On the issue of language proficiency and ethnic identity, which are acculturation measures used in existing health literature (Afable-Munsuz & Brindis, 2006; Lara, Gamboa, Kahramanian, Morales, & Bautista, 2005), segmented assimilation theory does not assume uni-directional change toward the norm. Rather, it proposes that immigrant groups selectively adapt traits/norms of the host culture and retain those of their culture of origin depending on their context. Thus, depending on how ethnic identities, socioeconomic factors and social norms change from one generation to the next, assimilation may lead to higher or lower levels of physical activity.

While several studies have applied segmented assimilation theory to health outcomes (Acevedo-Garcia, Pan, Jun, Osypuk, & Emmons, 2005; Finch & Lim, 2004; Frank, Cerda, & Rendon, 2007; Nagasawa, Qian, & Wong, 2001), we are not aware of any that have applied this framework to physical activity among adults. It is possible that diverse assimilation experiences of different ethnic groups will have differential implications for PA. Further, previous research suggests racial and ethnic differences exist in barriers to PA (Heesch, Brown, & Blanton, 2000) suggesting that aggregate analyses may mask important

ethnic-specific patterns. To this end, and to our knowledge, this study is the first US population-based study to examine physical activity in Mexican, Chinese and Filipino adults in a comparative manner, and includes measures of leisure, non-leisure and a combination of both types of physical activity together.

Hypotheses

Following segmented assimilation theory, we conceptualize immigrant generation as reflecting one's level of acculturation and degree of social mobility. We expect lower levels of total PA with each successive generation due to an upward SES shift from active to more sedentary occupations; upward mobility also encompasses more time constraints, and therefore, immigrants will have less time for both non-leisure and leisure activities. However, we also recognize that the opportunities for and social norms regarding physical activity vary by ethnic origin, potentially leading to differential associations between generation and physical activity by ethnic origin. We will examine these hypotheses with the following research questions: 1) What is the nature of the relationship between generation and levels of different types of PA? 2) Does the relationship vary by ethnic origin? 3) Do individual and neighborhood-level SES factors attenuate the relationship between generation and PA level?

Methods

Data

We linked neighborhood-level data from the **2000 US Census** (Summary Files 1 and 3) to individual-level data from the **2005 California Health Interview Survey** (CHIS) (Adult Module), the largest cross-sectional telephone survey in California. This linkage obtained a rich array of variables that permitted the measurement of physical activity; individual measures of acculturation and neighborhood-level measures relevant to the study of acculturation. Analyses were stratified by self-reported ethnic origin for Mexican (N = 6008), Chinese (N = 1313) and Filipino (N = 572) adults. All adults 18 years and over who did not report having difficulty walking were included in our analysis.

Dependent variable

Physical activity in CHIS 2005 is based on recall of daily activity patterns in the last 7 days. We first constructed two binary outcomes based on US guidelines for physical activity recommended by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM): 1) whether the respondent met the minimum requirements with leisure-time physical activities (LTPA) which included moderate-intensity activity (walking, bicycling, swimming, dancing and gardening) and vigorous-intensity activity (aerobics, running, soccer, fast bicycling, fast swimming) activities; and 2) whether the respondent met the minimum requirements with non-leisure time physical activities (NLTPA), which included occupational (walking at work) and transportation (walking/biking to work and/or for errands) activities. A respondent was defined as meeting the minimum PA requirements with LTPA if he/she was classified as engaging in 1) three or more days per week of vigorousactivityat least 20 minper day, or 2) five or more days per week of moderate-intensity activity at least 30 min per day (Haskell et al., 2007). A respondent was defined as meeting the minimum PA requirements with NLTPA if he/she met at least one of two conditions: 1) a full-time job and walking at work most of the day; or 2) expending at least 450 METs-min/week with transportation-related activities (Haskell et al., 2007). Walking was considered a moderate activity and assigned an MET value of 4 (Ainsworth et al., 2000). Finally, a third binary outcome, any PA, refers to whether the respondent was classified as meeting minimum PA requirements with any combination of

LTPA or NLTPA. For example, if a person did not meet minimum PA requirements with a leisure-time activity such as jogging, for example, he/she was still counted as meeting minimum PA requirements if he/she met minimum requirements with his/her work and/or transportation-related activity which occurs during non-leisure time.

Independent variables (CHIS, individual level)

Generation, a central variable in segmented assimilation theory, was the primary independent variable. In this study, a foreign-born respondent was classified as a first-generation immigrant; a US-born respondent who had at least one foreign-born parent was classified as second generation; if the respondent and both parents were born in the United States, he/she was classified as third generation. Given that language is a powerful symbol of ethnic identity (Giles & Johnson, 1987; Tong et al., 1999), **language spoken at home** and **language of interview** were included as measures of acculturation. Language spoken at home had three categories: whether the respondent speaks English only, whether the respondent speaks a combination of his/her native language (e.g. Spanish if Mexican, Mandarin/Cantonese if Chinese) and English, and whether the respondent speaks only his/her native language at home. **Language of interview** was a dichotomous variable categorized as English or native language; this variable was not included in the analyses of Filipino adults because CHIS was not conducted in a Filipino language such as Tagalog.

Age, sex, number of chronic conditions, marital status, education, family income, and urban/rural residence were covariates in the analysis (Berrigan et al., 2006; Evenson, Sarmiento, & Ayala, 2004; Kandula & Lauderdale, 2005; Wolin et al., 2006). Number of chronic conditions was a continuous count of the following conditions: asthma, cardiovascular disease, hypertension, diabetes and arthritis. Urban/rural residence is based on population density and classified geographic areas into 4 urbanization categories: urban, the most densely populated (representing most major metropolitan areas); 2nd city; suburban; and rural/town, the least populated (representing isolated towns and rural hamlets) (UCLA, 2006). Family income was measured as annual household income for family size as a % of the federal poverty level, using the categories <100%,101–200%, 201–300%, and >300% of poverty. Federal poverty level (FPL) was estimated based on published guidelines from the US Census Bureau for the relevant year (UCLA, 2006). Occupation was measured for those respondents who reported being currently employed full or part-time, and was collapsed into 6 categories based on 11 main occupation categories tabulated by the Census and Current Population Survey (UCLA, 2006). Consistent with a previous classification, the final six occupation categories were chosen to capture variation in occupational activity (King et al., 2001).

Independent variables (census, neighborhood level)

Neighborhood-level variables were measured at the census-tract-level. Neighborhood indicators of ethnic enclave described the percentage of persons who were born in the ethnic group's country of origin (Mexico, China or the Philippines) and the percentage of persons who spoke primarily English at home. We measured neighborhood affluence with three variables: educational level—the percentage of adults aged 25 and older with a college degree; family income—the proportion of households with a family income in 2000 greater than or equal to $125K (which represented the highest 12% of family incomes in California in 1999); and occupation – percentage of the employed civilian population aged 16 and over in professional/managerial occupations (not including administrative/office support). These measures capture the availability of material and social resources (Wen, Browning, & Cagney, 2003) which is important when viewing LTPA as a commodity that requires income and discretionary time (Kandula & Lauderdale, 2005). Additionally, we measured the percentage of the employed civilian population aged 16 and over who use a car, truck or

van as the main source of transportation as an indicator of wealth as well as the extent to which individuals might rely on sedentary means of transportation. All neighborhood-level variables were treated as continuous.

Analytic procedures

CHIS collects respondent's residential address thus facilitating geocoding for linkage to geographically-bounded areas such as census tract. Using census tract, we merged the CHIS data with a dataset containing census-tract-level information. Because respondents' address data is confidential, the linked Census-CHIS dataset was generated by the Data Access Center (DAC), based at the UCLA Center for Health Policy Research, which provides a controlled environment ensuring respondent confidentiality. All analyses were conducted in SAS and weighted, using SUDAAN, to account for the CHIS multi-stage cluster design. We did not expect clustering by census tract (the mean number of respondents per census tract was less than 2) and as such, did not employ hierarchical modeling techniques. In descriptive analysis, proportions were compared with chi-square tests and linear tests for trend (where appropriate). In the modeling stage, two different logistic regression models predicting the PA outcomes were examined. To address the first research question, we examined the effect of generation on PA levels adjusting for age, gender, marital status and number of chronic conditions (referred to as the base model). Second, all individual and neighborhood SES measures including occupation were added to examine whether their addition attenuates the relationship between generation and PA level (referred to as the adjusted model).

Results

Sample characteristics

Characteristics of adults who met the inclusion criteria are presented by ethnic group (Table 1). The majority of Mexican, Chinese and Filipino adults were first-generation immigrants (59%, 79% and 71% respectively). The percentage of adults who reported speaking English at home range from 17% among Mexican and Chinese adults to 34% among Filipino adults; being bilingual at home ranged from 34% among Chinese adults to 51% among Mexican and Filipino adults. Socioeconomic factors varied by ethnic group. For example, the percentages of college graduation ranged from only 10% among Mexican adults to 50% among Chinese and Filipino adults. Further, the percentage reporting a family income 0–99% FPL ranged from only 9% among Filipino adults to 28% among Mexican adults.

Language preference varied significantly by generation among all three ethnic groups. For example, the proportion who reported speaking their native language at home declined significantly from over 50% in the first generation to less than 5% in the third generation among both Mexican and Chinese adults. Similarly socio-demographic characteristics differed significantly across generations. The proportions who reported a college degree or higher and a family income of 300% FPL and above increased from the first to third generations in both Mexican and Chinese adults. In contrast, the percentage of Filipino adults who reported a college degree or higher declined from the first to third generation (from 57% to 25%).

Levels of any PA, LTPA and NLTPA

Overall the percentage meeting the recommended levels of PA from any source (LTPA or NLTPA) ranged from 34% among Chinese adults to about 52% among Mexican and Filipino adults (Table 1). In additional CHIS analysis (data not shown in tables), the percentage meeting recommended PA levels from any source of PA is 47% among the native white population in the US; the percentage for NLTPA is 22% and for LTPA is 34%.

The percentages of both LTPA and NLTPA differed significantly by immigrant generation among Mexican adults, but in opposing directions; for example, the percentage meeting recommended LTPA increased from to 28% among 1st generation adults to 37% among 3rd generation adults while there was a significant negative trend for NLTPA decreasing from 35% to 28%. Among Chinese adults, the percentage meeting recommended LTPA increased significantly by immigrant generation from 20% among the 1st generation to 32% among 3rd generation adults; there was also a significant positive trend in any PA by generation. Among Filipino adults, NLTPA decreased significantly from 30% in the 1st generation to 20% in the 2nd generation and then increased to 43% in the 3rd generation.

Odds of physical activity (PA) outcomes associated with generation among Mexican adults

Table 2 displays the base model and fully adjusted odds ratios (and 95% confidence intervals) of the three different PA outcomes associated with generation among Mexican adults. In the base model, the odds of PA associated with generation were significant for LTPA and NLTPA but had opposing directions; for example, the odds of LTPA are significantly higher for 3rd generation (vs. 1st generation) (OR: 1.5, 95% CI: 1.3–1.9) but significantly lower for 3rd generation (vs. 1st generation) for NLTPA (OR:0.8, 95% CI:0.6, 0.9). These findings are generally consistent with the bivariate findings. After adjusting for all individual SES and neighborhood-level variables, the significant association between generation and LTPA remained. Further, it is notable that the odds of LTPA are significantly higher for Mexicans who are bilingual at home (vs. those who speak Spanish only). In contrast, the addition of the individual SES and neighborhood-level variables attenuated the association between generation and NLTPA. The likelihood of NLTPA was lower for adults with higher educational levels (e.g. OR for college graduate vs. less than HS was 0.6, 95% CI: 0.4, 0.8) and higher for those employed in manual occupations (vs. sedentary occupations) (e.g. OR for other manual vs. office/administrative: 2.9, 95% CI: 2.0, 4.3).

Odds of physical activity (PA) outcomes associated with generation among Chinese adults

In the base model, the odds of PA associated with generation were significant for any PA, LTPA and NLTPA (Table 3). After adjusting for all individual SES and neighborhood-level variables, the significant associations between generation and NLTPA remained. Being a 2nd generation immigrant (vs.1st generation immigrant) reduced the odds of NLTPA; for example, the OR for 2nd generation (vs. 1st generation) was 0.4 (95% CI: 0.2, 0.8). In contrast, English language interview (vs. Cantonese or Mandarin interview) increased the odds of NLTPA in addition to the odds for any PA and LTPA. Occupationwas also a significant predictor for any PA and NLTPA.

Odds of physical activity (PA) outcomes associated with generation among Filipino adults

In the base model, the odds of PA associated with generation are significant only for NLTPA (Table 4). The likelihood of NLTPA is lower for 2nd generation (vs. 1st generation) (OR: 0.4, 95% CI: 0.2–0.7). After adjusting for all individual and neighborhood-level SES variables, the significant effect of generation remained for NLTPA. Additionally, residence and occupation were significant predictors for NLTPA.

Discussion

This study demonstrates that immigrant generation is a significant determinant of at least one measure of PA among the three ethnic groups studied and the relationship between immigrant generation and PA varied by ethnicity and PA outcome measured. There was a positive association between later generation and LTPA among Mexican adults; and a negative association between generation and NLTPA among Chinese and Filipino adults.

These findings are partially consistent with results of past studies among diverse populations in the US (Berrigan et al., 2006; Crespo et al., 2001; Ham et al., 2007; Kandula & Lauderdale, 2005; Lee et al., 2000; Perez-Stable et al., 1994; Wolin et al., 2006).

SES attenuated some of the relationships between immigrant generation and PA. We found evidence of attenuation for NLTPA among Mexican adults and for LTPA among Chinese adults, but no attenuation for any of the PA outcomes among Filipino adults. These findings suggest that the mechanisms linking immigrant generation to PA are not similar across different ethnic groups, which is supported by empirical evidence of differential effects of acculturation on other health outcomes by ethnic origin (Allen et al., 2007; Zsembik & Fennell, 2005). As the results for the different groups were complex, suggesting various mechanisms, we discuss findings for LTPA and NLTPA separately and conclude with a discussion of implications for any PA.

Physical activity among Mexican adults

Among Mexican adults, the findings suggest that later generation is positively associated with LTPA, possibly reflecting changing social norms and opportunities for LTPA. For example, past research in diverse samples of women point to the importance of factors such as the balancing of family and work priorities, the lack of community support for exercise, and perceptions of body image (Eyler et al., 2002; Stevens, Kumanyika, & Keil, 1994). Thus, later generations of Mexican women may experience a shift in norms and opportunities, making LTPA more attainable.

It is also notable that bilingualism in the home was protective and residence in a neighborhood with a high concentration of English speakers (data not shown) had an adverse effect on LTPA, a finding consistent with evidence of positive associations between measures of biculturalism and other preventive behaviors (Harmon, Castro, & Coe, 1996; Palmer, Fernandez, Tortolero-Luna, Gonzales, & Dolan Mullen, 2005). These findings are also consistent with the positive social outcomes predicted by selective assimilation (Portes & Zhou, 1993) and the protective influence of biculturalism on health due to more effective adjustment to both cultures and more extended social support from both one's co-ethnic community and host society (Berry, 1992).

Occupation and educational level attenuated the negative association between generation and NLTPA, suggesting that later generation is associated with employment in sedentary occupations, which in turn is associated with a low likelihood of NLTPA. For example, the proportions of Mexican adults reporting having a college degree and being employed in professional or managerial occupation increased with each successive generation (Table 1). Though upward social mobility may be interpreted as a positive outcome in the segmented assimilation framework, it has negative implications for NLTPA, a major source of any PA among the Mexican population in our study (Table 1).

Physical activity among Chinese and Filipino adults

Language preference and urban/rural residence attenuated the association between generation and LTPA among Chinese adults. However, it is important to note that generation is highly correlated with language of interview; almost all 3rd generation Chinese adults had an English language interview (Table 1). Similar to our discussion above, it is possible that English language preference reflects greater exposure to information and social norms that encourage PA. It should also be noted, however, that because CHIS does not probe about ethnic-specific physical activities, it is possible that English language interview was indicative of the type of LTPA Chinese adults engaged in rather than an indication of whether they met recommended PA levels; less acculturated Chinese adults may have been

less likely to report LTPA probed in this study but may possibly be meeting recommended PA levels with other forms of ethnic-specific PA (e.g. tai-chi).

It is striking that even after adjusting for SES factors including occupation, the significant association between generation and NLTPA persists in both groups. Being a 2nd generation (vs. 1st generation) adult has an adverse effect on NLTPA, an effect that is not sustained in the 3rd generation. These findings require more qualitative inquiry but may suggest two potential mechanisms. For Filipino adults, examination of socioeconomic factors by generation (Table 1) reveals that the percentage of college educated adults significantly declined from one generation to the next, which suggests a downward assimilation process, a finding consistent with previous work on the Filipino second generation (Zhou & Xiong, 2005). This downward assimilation may suggest more limited exposure to opportunities, information and social norms that encourage physical activity. In contrast, as Chinese adults experience upward social mobility, which our analysis suggests (Table 1), they may confront greater time constraints and enter more time-demanding occupations. As a result, they may place lesser value on more time-consuming, but active means of transportation for work and errands.

Limitations

This study has several limitations. As discussed above, CHIS is limited in its range of physical activity questions which did not allow us to measure several forms of housework (cleaning, vacuuming, heavy laundry, childcare) and strenuous occupational activity (such as that involved in construction work). Estimated levels of PA were based on self-report; yet, previous studies have validated other self-report PA recall instruments with direct measures of PA and weekly logs (Blair et al., 1985; Taylor et al., 1984). Finally, because this study relies on cross-sectional data, it is beyond the scope to estimate temporal effects, which would help to establish causality. Nevertheless, we present the first population-based study of immigrant generation and physical activity among Mexican, Chinese and Filipino adults who represent the three largest immigrant groups in the US; we also consider all three outcomes of physical activity: leisure, non-leisure and any physical activity, which is necessary data for tailoring interventions.

Conclusion

This study demonstrates the necessity of considering SES when conceptualizing pathways explaining variation in PA by immigrant generation and the potential diversity of pathways linking generation or related acculturation measures to PA and health in general. To fully understand and appreciate this complexity, we advocate for a more rigorous study of the inter-related processes of social mobility and acculturation and their influence on health. Although a closer examination of other sources of physical activity is warranted, this study suggests promising directions for interventions among the different ethnic groups in this study including the promotion of LTPA among earlier generations of Mexican and Chinese adults.

Further, to the extent that NLTPA constitutes a major source of physical activity as it does in the Mexican and Filipino populations in our study, interventions need to promote both NLTPA and LTPA, as opposed to solely focusing on LTPA. The lower levels of NLTPA among later generations of immigrant adults in this California-based study are consistent with population-wide declines in NLTPA in the US (Brownson, Boehmer, & Luke, 2005). In light of the varied circumstances faced by the immigrant groups studied here (i.e. the time constraints faced by some upwardly mobile immigrants and reduced opportunities for PA for others), PA interventions that address adults' leisure and non-leisure time, particularly in

the workplace (IOM, 2005), have a greater potential to reduce the progression of chronic disease in countries such as the US with an increasingly diverse population.

Acknowledgments

The research for this paper was supported by a grant from the Robert Wood Johnson Foundation funded Network for Multicultural Research on Health and Healthcare at the University of California, Los Angeles (UCLA) and in part by the National Institute on Aging (NIA) funded Resource Center for Minority Aging Research (RCMAR) Center for Aging in Diverse Communities at the University of California, San Francisco. Dr. Rodriguez was also partially supported by DREW/UCLA Project EXPORT, NCMHD, P20MD000182. Dr. Ponce was partially funded by NIH/NCI K07 CA 100097. Authors wish to thank Steven Gregorich for his statistical guidance on an earlier draft of this paper.

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Table 1

Sample socio-demographic characteristics and physical activity levels, weighted percentages: CHIS 2005.

	Tests	Mexican				Chinese				Filipino			
		Generation			Total	Generation			Total	Generation			Total
		1st	2nd	3rd	*N*	1st	2nd	3rd	*N*	1st	2nd	3rd	*N*
Total sample		59.3	24.6	16.2	6008	78.9	16.2	5.0	1313	71.3	23.0	5.7	722
Language at home	*a,b,c*												
English		1.6	19.8	70.5	17.1	6.0	48.3	91.4	16.8	15.6	76.5	87.3	33.7
English/native		47.6	73.3	27.9	51.0	35.1	42.9	5.1	34.4	64.6	19.1	12.7	51.2
Native language		50.8	6.9	1.6	32.1	58.9	8.8	3.5	48.8	19.8	4.4	0.0	15.1
Interview language	*a,b*												
English		22.0	91.8	99.8	51.7	41.8	99.7	100.0	53.1	n/a	n/a	n/a	n/a
Native		78.0	8.2	0.2	48.3	58.2	0.3	0.0	46.9	n/a	n/a	n/a	n/a
Gender	*c*												
Male		52.9	48.6	47.9	51.2	42.1	51.7	54.1	44.3	41.0	60.8	48.3	46.0
Age	*a,b,c*												
18–29		28.3	50.9	35.5	34.9	16.7	43.5	38.0	22.1	16.6	58.9	54.4	28.5
30–39		32.1	19.3	19.5	27.0	23.4	18.6	19.6	22.5	21.1	21.6	28.4	21.6
40–49		21.9	9.9	23.4	19.2	22.7	12.8	20.6	20.8	22.3	9.8	13.7	18.9
50+		17.7	20	21.6	19	37.1	25.1	21.9	34.6	40.0	9.7	3.7	31.0
Educational level	*a,b,c*												
Less than high school		60.6	15.7	12.3	41.8	15.6	2.3	3.9	13.0	4.0	1.4	5.9	3.5
High school graduate		23.0	40.6	35.8	29.4	20.2	21.7	16.0	20.4	15.9	21.1	16.4	17.2
Some college/vocational		11.3	27.1	33.7	18.8	15.8	24.1	21.7	17.2	23.4	39.9	53.1	28.9
College or higher		5.1	16.6	18.2	10.0	48.3	52.0	58.4	49.4	56.7	37.5	24.7	50.4
Poverty level	*a,b,c*												
0–99% FPL		37.5	16.6	10.8	28.1	14.6	5.3	3.6	12.8	8.8	3.5	25.7	8.6
100–199% FPL		37.9	25.0	18.7	31.7	20.5	12.4	7.8	18.6	15.9	18.5	9.2	16.1
200–299% FPL		12.0	15.4	16.6	13.7	12.5	15.7	14.3	13.2	15.8	14.3	6.3	14.9
300% FPL+		12.7	43.0	53.8	26.6	52.3	66.6	74.3	55.4	59.4	63.6	58.9	60.4
Occupation	*a*												

	Tests	Mexican				Chinese				Filipino			
		Generation			Total	Generation			Total	Generation			Total
		1st	2nd	3rd	*N*	1st	2nd	3rd	*N*	1st	2nd	3rd	*N*
Professional/managerial		5.7	17.2	24.5	11.6	32.9	34.6	43.8	33.7	39.4	27.6	29.8	36.1
Physical activity													
Any	*e*	52.0	52.0	54.1	52.4	31.8	40.0	49.2	34.0	52.2	46.4	73.7	52.1
Leisure-time	*a,b,d,e*	28.2	33.2	36.7	30.8	20.4	30.2	32.2	22.6	32.5	34.5	48.4	33.8
Non-leisure time	*a,c,d*	35.0	28.8	28.0	32.3	16.7	15.7	32.1	17.3	30.3	19.5	42.8	28.5

[a] chi-square $p < 0.05$ Mexican adults;

[b] chi-square $p < 0.05$ Chinese adults;

[c] chi-square $p < 0.05$ Filipino adults;

[d] test for trend $p < 0.05$ Mexican adults;

[e] test for trend $p < 0.05$ Chinese adults.

Table 2

Odds ratios (and 95% CI) for recommended physical activity: CHIS 2005 Mexican adults.

	Any physical activity		Leisure-time physical activity		Non-Leisure time physical activity	
	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]
Generation						
1st	1.0	1.0	1.0	1.0	1.0	1.0
2nd	1.0 (0.9, 1.2)	1.0 (0.8, 1.3)	1.3 (1.1, 1.5)[c]	1.1 (0.8, 1.3)	0.8 (0.6, 0.9)[c]	0.9 (0.7, 1.1)
3rd	1.2 (1.0, 1.4)	1.2 (0.9, 1.5)	1.5 (1.3, 1.9)[c]	1.4 (1.0, 1.9)[d,e]	0.8 (0.6, 0.9)[c]	0.8 (0.6, 1.1)
Language at home						
Native		1.0		1.0		1.0
English & native		1.2 (0.9, 1.5)		1.4 (1.1, 1.7)[c]		1.0 (0.8, 1.3)
English		1.0 (0.7, 1.5)		1.1 (0.8, 1.5)		1.0 (0.6, 1.4)
Interview language						
Native		1.0		1.0		1.0
English		1.1 (0.8, 1.5)		0.9 (0.7, 1.1)		1.2 (0.9, 1.7)
Educational level						
Less than HS		1.0		1.0		1.0
Completed HS		1.0 (0.8, 1.3)		1.2 (1.0, 1.5)		1.0 (0.8, 1.2)
Some college		1.1 (0.9, 1.4)		1.4 (1.1, 1.7)		1.0 (0.7, 1.3)
College graduate		0.9 (0.7, 1.2)		1.3 (1.0, 1.8)		0.6 (0.4, 0.8)[c]
Graduate		1.0 (0.6, 1.6)		1.4 (0.9, 2.0)		0.8 (0.5, 1.4)
Poverty level						
0–99% FPL		1.0		1.0		1.0
100–199% FPL		1.0 (0.8, 1.2)		0.8 (0.7, 1.0)		1.1 (0.8, 1.4)
200–299% FPL		0.9 (0.7, 1.2)		0.9 (0.7, 1.2)		0.9 (0.7, 1.3)
300% FPL and above		1.0 (0.7, 1.3)		1.1 (0.8, 1.4)		0.9 (0.7, 1.3)
Residence						
Urban		1.0 (0.8, 1.3)		1.0 (0.8, 1.3)		0.9 (0.6, 1.3)
2nd city		0.9 (0.7, 1.2)		1.0 (0.8, 1.2)		0.8 (0.6, 1.1)
Suburban		1.0 (0.7, 1.4)		1.0 (0.7, 1.3)		0.9 (0.6, 1.4)
Rural		1.0		1.0		1.0

	Any physical activity		Leisure-time physical activity		Non-Leisure time physical activity	
	Base model[a]	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**
Occupation						
Unemployed		0.5 (0.4, 0.7)		1.4 (1.0, 1.8)[c,e]		0.1 (0.0, 0.1)
Professional		1.2 (0.9, 1.5)		1.2 (0.9, 1.6)		1.1 (0.8, 1.4)
Service, sales		1.9 (1.5, 2.5)[c]		1.0 (0.7, 1.4)		2.2 (1.6, 2.9)[c]
Repair, production, transportation		1.3 (0.9, 1.7)		1.1 (0.8, 1.5)		1.1 (0.8, 1.5)
Other manual[f]		2.5 (1.7, 3.7)[c]		0.9 (0.6, 1.3)		2.9 (2.0, 4.3)[c]
Office, administrative		1.0		1.0		1.0

[a] Base model adjusted for individual-level variables: age, gender, marital status, and number of chronic conditions.

[b] Adjusted model adjusts for all variables in base model, all individual-level SES variables shown, and neighborhood-level variables: % with college education, % with high family income, % employed in managerial/profession occupations; % who use private vehicle for transportation, % born in country of origin, and % who use primarily English at home.

[c] $p < 0.05$.

[d] $p < 0.10$.

[e] CI does not contain 1.0 when rounding to 2 decimal places.

[f] Farming, forestry, fishing, construction/extraction, armed forces.

Table 3

Odds ratios (and 95% CI) for recommended physical activity: CHIS 2005 Chinese adults.

	Any physical activity		Leisure -time physical activity		Non-leisure time physical activity	
	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]
Generation						
1st	1.0	1.0	1.0	1.0	1.0	1.0
2nd	1.3 (0.9, 2.0)	0.7 (0.4, 1.4)	1.7 (1.1, 2.6)[c]	0.9 (0.5, 1.5)	0.8 (0.4, 1.3)	0.4 (0.2, 0.8)[c]
3rd	1.9 (1.1, 3.5)[d]	0.8 (0.3, 1.9)	1.8 (0.8, 3.8)	0.8 (0.3, 2.0)	2.1 (1.1, 4.3)[d]	0.8 (0.3, 2.1)
Language at home						
Native		1.0		1.0		1.0
English & native		1.1 (0.6, 1.8)		0.9 (0.6, 1.4)		1.2 (0.7, 2.0)
English		2.2 (1.0, 5.0)		1.7 (0.9, 3.1)		2.2 (1.0, 4.7)
Interview language						
Native		1.0		1.0		1.0
English		2.6 (1.6, 4.1)[c]		2.4 (1.5, 3.7)[c]		2.6 (1.5, 4.4)[c]
Educational level						
Less than HS		1.0		1.0		1.0
Completed HS		0.9 (0.4, 2.0)		1.1 (0.5, 2.3)		0.9 (0.4, 2.0)
Some college		1.0 (0.3, 2.9)		1.7 (0.7, 4.2)		1.0 (0.4, 2.6)
College graduate		0.6 (0.2, 1.8)		1.0 (0.4, 2.5)		0.5 (0.2, 1.3)
Graduate		0.8 (0.3, 2.3)		1.5 (0.6, 3.6)		0.5 (0.2, 1.3)
Poverty level						
0–99% FPL		1.0		1.0		1.0
100–199% FPL		1.3 (0.6, 3.2)		0.7 (0.4, 1.4)		1.7 (0.7, 4.2)
200–299% FPL		2.3 (0.9, 5.9)		1.5 (0.6, 3.5)		2.5 (1.0, 6.6)
300% FPL and above		1.6 (0.7, 3.7)		1.2 (0.6, 2.3)		1.9 (0.8, 4.7)
Residence						
Urban		1.3 (0.4, 4.1)		1.8 (0.6, 5.7)		1.9 (0.4, 8.4)
2nd city		0.9 (0.3, 2.9)		2.0 (0.6, 6.4)		1.1 (0.3, 3.9)
Suburban		0.6 (0.2, 1.7)		1.2 (0.4, 4.2)		0.8 (0.2, 3.4)
Rural		1.0		1.0		1.0

	Any physical activity		Leisure -time physical activity		Non-leisure time physical activity	
	Base model[a]	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**
Occupation						
Unemployed		0.9 (0.5, 1.7)		1.4 (0.7, 2.8)		0.1 (0.1, 0.3)
Professional		1.1 (0.6, 2.1)		1.1 (0.6, 2.2)		0.8 (0.4, 1.6)
Service, sales		1.8 (0.9, 3.4)		1.0 (0.5, 2.1)		2.4 (1.2, 4.8)[c]
Repair, production, transportation		1.8 (0.8, 4.1)		0.7 (0.2, 2.1)		1.7 (0.6, 4.7)
Other manual[e]		8.2 (2.1, 38.6)[c]		1.4 (0.2, 11.2)		11.2 (2.7, 47.0)[c]
Office, administrative		1.0		1.0		1.0

[a] Base model adjusted for individual-level variables: age, gender, marital status, and number of chronic conditions.

[b] Adjusted model adjusts for all variables in base model, all individual-level SES variables shown, and neighborhood variables: % with college education, % with high family income, % employed in managerial/profession occupations, % who use private vehicle for transportation, % born in country of origin, and % who use primarily English at home.

[c] $p < 0.05$.

[d] $p < 0.10$.

[e] Farming, forestry, fishing, construction/extraction, armed forces.

Table 4

Odds ratios (and 95% CI) for recommended physical activity: CHIS 2005 Filipino adults.

	Any physical activity		Leisure-time physical activity		Non-leisure time physical activity	
	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]	Base model[a]	Adjusted model[b]
Generation						
1st	1.0	1.0	1.0	1.0	1.0	1.0
2nd	0.6 (0.4, 1.1)	0.7 (0.3, 1.5)	1.1 (0.6, 1.8)	1.1 (0.6, 2.2)	0.4 (0.2, 0.7)[c]	0.4 (0.2, 0.9)[c]
3rd	2.1 (0.8, 6.0)[d]	2.5 (0.8, 7.5)	2.0 (0.6, 6.1)	1.8 (0.4, 7.3)	1.2 (0.3, 4.5)	1.9 (0.5, 7.7)
Language at home						
Native		1.0		1.0		1.0
English & native		1.0 (0.6, 1.6)		1.2 (0.6, 2.4)		0.9 (0.5, 1.7)
English		0.9 (0.4, 1.9)		1.5 (0.7, 3.3)		0.5 (0.2, 1.2)
Educational level						
Less than HS		1.0		1.0		1.0
Completed HS		0.5 (0.1, 1.8)		0.9 (0.2, 3.5)		0.6 (0.1, 2.4)
Some college		1.2 (0.4, 3.5)		1.3 (0.4, 4.3)		1.4 (0.3, 5.8)
College graduate		1.2 (0.4, 3.6)		2.2 (0.6, 8.5)		0.8 (0.2, 3.1)
Graduate		1.6 (0.5, 5.4)		1.4 (0.3, 6.2)		2.5 (0.6, 11.7)
Poverty level						
0–99% FPL		1.0		1.0		1.0
100–199% FPL		0.9 (0.3, 2.3)		0.7 (0.2, 2.3)		1.8 (0.4, 7.5)
200–299% FPL		1.0 (0.3, 2.8)		0.8 (0.3, 2.4)		1.4 (0.3, 5.8)
300% FPL and above		1.1 (0.5, 2.5)		0.8 (0.3, 2.2)		1.8 (0.4, 8.0)
Residence						
Urban		3.9 (1.2, 12.4)		2.9 (1.0, 8.9)		7.4 (1.5, 37.5)[c]
2nd city		3.1 (1.0, 10.2)		2.1 (0.8, 5.6)		7.5 (1.0, 59.9)
Suburban		2.9 (1.0, 8.3)		2.0 (0.7, 6.0)		6.4 (1.4, 30.1)[c]
Rural		1.0		1.0		1.0
Occupation						
Unemployed		1.0 (0.5, 2.2)		1.9 (0.9, 4.3)		0.0 (0.0, 0.2)
Professional		1.5 (0.7, 3.1)		1.1 (0.5, 2.2)		2.1 (0.8, 5.6)

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	Any physical activity		Leisure-time physical activity		Non-leisure time physical activity	
	Base model[a]	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**	**Base model[a]**	**Adjusted model[b]**
Service, sales		2.2 (1.1, 4.3)		0.7 (0.3, 1.7)		5.2 (2.0, 13.2)[c]
Repair, production, transportation		0.8 (0.3, 1.8)		1.0 (0.4, 2.7)		1.7 (0.7, 4.1)
Other manual[e]		1.0 (0.1, 8.2)		1.4 (0.2, 11.5)		3.5 (0.3, 35.6)
Office, administrative		1.0		1.0		1.0

[a] Base model adjusted for individual-level variables: age, gender, marital status, and number of chronic conditions.

[b] Adjusted model adjusts for all variables in base model, all individual-level SES variables shown, and neighborhood variables: % with college education, % with high family income, % employed in managerial/profession occupations, % who use private vehicle for transportation, % born in country of origin, and % who use primarily English at home.

[c] $p < 0.05$.

[d] $p < 0.10$.

[e] Farming, forestry, fishing, construction/extraction, armed forces.