Acculturation and activity behaviors in Chinese American immigrants in New York City

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ABSTRACT

Asian Americans have lower levels of physical activity (PA) compared to other racial/ethnic groups; however, there is little understanding of the social and cultural determinants of PA in this population. Few analyses describe specific PA domains (occupation-, transportation-, recreation-related), focus on one Asian subgroup, or use validated scales. The study objective was to assess the association between acculturation and activity behaviors (meeting 2008 PA guidelines, activity minutes by PA domain, sitting time) in a cross-sectional sample of urban-dwelling, Chinese American immigrants. Data were from the Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11 among participants with valid reports of PA minutes, assessed by the WHO Global Physical Activity Questionnaire ($n = 1772$). Acculturation was assessed using the Stephenson Multigroup Acculturation Scale, a 32-item instrument which characterizes two acculturative dimensions: ethnic society (Chinese) immersion and dominant society (American) immersion (maximum possible scores = 4). Multivariable models regressing activity behaviors on acculturation were run, adjusting for age, sex, household income, education, and age at immigration. Ethnic society immersion was high (mean = 3.64) while dominant society immersion was moderate (mean = 2.23). Higher ethnic society immersion was associated with less recreation-related PA (−40.7 min/week); higher dominant society immersion was associated with a higher odds of meeting PA guidelines (OR: 1.66 (1.25, 2.20), $p < 0.001$) and more recreation-related PA (+36.5 min/week). Given low PA levels in Chinese adults in China, results suggest that PA for leisure may increase and become a more normative behavior among Chinese American immigrants with acculturation. Understanding acculturation level may inform strategies to increase PA in Chinese Americans.

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1. Introduction

Physical activity (PA) is a beneficial health behavior, associated with reduced risk of chronic disease (Artinian et al., 2010). The 2008 U.S. Physical Activity Guidelines for Americans (PAGA), recommends that adults should engage in 150 min/week of moderate-intensity, or 75 min/week of vigorous-intensity PA, or an equivalent combination of moderate- and vigorous-intensity PA to meet aerobic guidelines (United States Department of Health and Human Services, 2008). According to recent national data from the HealthStyles survey and the Behavioral Risk Factor Surveillance System (BRFSS), only 36.1% of adults were aware of the 2008 PAGA (Kay et al., 2014) and only 51.6% of adults met the aerobic guidelines, respectively (Centers for Disease, C. and Prevention, 2013).

Asian Americans have been documented to have lower levels of recreation-related PA (Afable-Munsuz et al., 2010; Kandula and Lauderdale, 2005; Li and Wen, 2013; Maxwell et al., 2012; Yi et al., 2015) and higher sitting times (Bartley et al., 2013) compared to other racial/ethnic groups. In analyses of population-based data representative of their respective geographies, adults of racial/ethnic groups were more likely to meet PA guidelines measured by self-reported moderate and vigorous activity minutes compared to Asian Americans after adjustment for covariates in New York City (NYC; white OR: 1.35 [1.09–1.68]; black OR: 1.61 [1.28–2.02]; Hispanic OR: 2.14 [1.74–2.62]) and in Los Angeles County (white OR: 1.45 [1.13–1.86]; Hispanic OR: 1.71 [1.32–2.22]) (Yi et al., 2015). Asian Americans are also less likely to report having family members, friends or neighbors who exercise (i.e., lower levels of descriptive norms around PA) (Firestone et al., 2015). Physical activity does not appear to be as much of a cultural norm in Asia as it is in the U.S. (Ha et al., 2010; Zhou and Cheah, 2015). For instance, the prevalence of recreation-related PA in China has been shown to be quite low; 24.5% of Chinese adults reported recreation-related PA in the InterASIA study, which includes a

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nationally representative sample of the Chinese general adult population (Muntner et al., 2005). Though Asian Americans have a lower prevalence of obesity (11% vs. 33–48% in other racial/ethnic groups), (Ogden et al., 2014) they are more likely to develop hypertension and diabetes at lower body mass index values than other racial/ethnic groups (Wong et al., 2014). This may be because Asian Americans tend to have higher percent body fat for the same body mass index compared to their white counterparts (Deurenberg et al., 2002).

There is limited understanding of the social and cultural determinants of PA and other risk factor behaviors among Asian Americans, which is further exacerbated by the common practice of aggregating across multiple diverse Asian subgroups (e.g., Chinese, Asian Indian, Vietnamese, Korean, Filipino, Japanese) (Islam et al., 2010). These Asian subgroups have vastly different socioeconomic and cultural characteristics and therefore differing contextual and physical opportunities for PA. Thus, analyses focused on one specific Asian subgroup pertaining to lifestyle behaviors and cardio-metabolic health is warranted.

Chinese Americans represent the largest Asian subgroup in the U.S. at over 4 million people, and make up 22.8% of all Asian Americans (Hoeffel et al., 2012). Asian Americans were the fastest growing racial/ethnic group in the United States over the past ten years (Hoeffel et al., 2012). From 2000 to 2010, the population of Chinese Americans (includes China, Taiwan, Hong Kong) grew by 40% nationally (Hoeffel et al., 2012). Locally in NYC during the same time period, the Chinese population grew by 34% (Asian Americans in New York City, 2012). Chinese American immigrants make up the largest Asian American subgroup nationally and in NYC (Pew Research Center, 2012; Frey, 2011). A few papers have explored the determinants of PA in Chinese Americans, including indirect measures of acculturation, such as length of time in the U.S. and English language use – though none have used a comprehensive scale of acculturation (Afable-Munsuz et al., 2010; Li and Wen, 2013; Afable et al., 2016; Bhattacharya Becerra et al., 2015). In both regionally representative data (California) and in local data (NYC), longer time spent in the U.S. was positively associated with increased recreation-related PA and meeting PA guidelines (Li and Wen, 2013; Afable et al., 2016; Bhattacharya Becerra et al., 2015). Findings around English language use are mixed, perhaps owing to nuances in variables used. For example, English language proficiency (among those who do not speak English well) is not associated with recreation-related PA, (Li and Wen, 2013) while English language being spoken in the home or being bilingual (English/Chinese) is associated with more non-recreation-related PA (Afable-Munsuz et al., 2010; Bhattacharya Becerra et al., 2015).

In the current analysis, we measure acculturation using a multi-item, validated scale, as opposed to factors related to the acculturation process as in prior studies. In addition, while some investigations have included one or more PA domains such as occupation-related PA, leisure-time PA or walking, (Afable-Munsuz et al., 2010; Li and Wen, 2013; Bhattacharya Becerra et al., 2015; Li et al., 2014), only one prior investigation examined all PA domains (occupation-, transportation-, recreation-related) in the same paper, (Afable et al., 2016) and none have characterized sitting time. The purpose of this analysis was threefold: 1) to characterize activity behaviors by demographic factors; and 2) to describe acculturation scores by demographic factors to understand potential confounding of these covariates in the association between acculturation and PA; and 3) to assess the association between acculturation and activity behaviors (meeting 2008 PA guidelines, activity minutes by PA domain, sitting time) in a cross-sectional sample of Chinese American immigrants residing in an urban area.

2. Materials and methods

Data for this analysis were from the Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11. The CHA CHA study was a cross-sectional survey using a community-based, convenience sample of foreign-born Chinese American adult New Yorkers ($n = 2071$)

conducted by researchers at the Albert Einstein College of Medicine, in collaboration with the Chinese Community Partnership for Health (CCPH) of New York-Downtown Hospital (currently named New York-Presbyterian/Lower Manhattan) (Afable et al., 2016; Rajpathak and Wylie-Rosett, 2011a). Participants were recruited by CCPH to take part in a community cardiovascular screening initiative. The CCPH disseminated information about the screening program through Chinese language media as well as senior centers, and businesses located in the Chinese communities in lower Manhattan and Sunset Park, Brooklyn. The CCPH staff scheduled appointments that took place at New York-Presbyterian/Lower Manhattan Hospital's Manhattan and Brooklyn ambulatory care sites. All participants provided written informed consent prior to blood testing and assessments. During the scheduled clinic appointments, trained CCHP staff obtained fasting blood, anthropometric measures, and collected participants' self-administered socio-demographic, acculturation and behavioral information – including diet using a Chinese-modified food frequency questionnaire (Tseng and Hernandez, 2005) and a culturally adapted Global Physical Activity Questionnaire (GPAQ). All survey instruments were presented in English and with a Chinese translation shown underneath each question. The Institutional Review Board of the Albert Einstein College of Medicine and the New York Downtown Hospital approved this study.

2.1. Outcomes: activity behaviors variables

The GPAQ (Cleland et al., 2014) was developed by the World Health Organization (WHO) and collects information on PA in three domains: occupation, travel (walking, biking) and recreation (leisure-time) and on time spent sitting. A series of questions on moderate and vigorous activity for each domain (15 total) were asked based on a skip pattern of the preceding question. Sitting time was assessed with the question, "How much time do you spend sitting or reclining on a typical day?" GPAQ data were cleaned and coded based on WHO analytic guidelines (World Health Organization, 2014). Mean minutes/week for each of the three domains was calculated based on responses, and summed for total PA, total moderate PA and total vigorous PA minutes/week. The binary outcome of meeting 2008 PAGA was defined as having ≥150 min/week of moderate activity or ≥75 min/week of vigorous activity. Sitting time was assessed in min/day.

2.2. Primary exposure: acculturation and other covariates

Acculturation was assessed using the Stephenson Multigroup Acculturation Scale (SMAS) (Stephenson, 2000). The SMAS is a 32-item scale which asks about various aspects of life, including language, social characteristics (e.g., food and music preferences, ethnicity of friends), and political leanings. Two dimensions of acculturation may be calculated from the SMAS: ethnic society immersion and dominant society immersion. The first dimension, ethnic society immersion, is a marker of how closely the individual identifies with the culture of their 'native country' or 'country of origin'. The second dimension, dominant society immersion, is a marker of how closely the individual identifies with the culture of their host country – in this case the U.S. respondents rate their responses to these items on a scale of 1 to 4 (false, partly false, partly true, true). To estimate ethnic society immersion, the responses to the first 17 items of the SMAS are summed and an average across responses is calculated, with a maximum total score of 4. To estimate dominant society immersion, the responses to items 18 to 32 of the SMAS are summed and an average across responses is calculated, also with a maximum total score of 4. Prior literature has suggested that the acculturation dimensions may operate independently of one another among foreign-born Chinese Americans, though controversy exists (Yoo et al., 2013a). We therefore considered each dimension as separate for primary analyses – an approach that has been previously applied, (Berry, 1997; Calzada et al., 2012) and present an interaction analysis between the two dimensions as secondary (Berry, 2003). All other characteristics

(age, sex, household income, education, age at immigration) were self-reported.

2.3. Statistical analysis

Mean ethnic society immersion and dominant society immersion scores were assessed, and stratified by demographics characteristics; differences were assessed using t-tests. Each of the activity behavior outcomes (meeting PA guidelines, PA min/week total, moderate, vigorous and by domain, sitting time per week) was stratified by demographics, and differences were assessed using t-tests for proportions for categorical variables and t-tests for continuous variables. To better understand the relationship between acculturation and PA outcomes, acculturation scores across different demographic groupings were compared using t-tests. Differences by demographics in meetings PA guidelines were assessed using t-tests for proportions; all other differences in activity behavior minutes were assessed using t-tests. Separate multivariable linear and logistic regression models were used to assess the association of ethnic society immersion and dominant society immersion with each activity behavior outcome, adjusted for age, sex, household income, and education. For the interaction analyses, binary variables of at or above (high) or below (low) the mean ethnic and dominant society immersion scores were created (data were normally distributed). The interaction term between the two scores was included in logistic and linear regression models, creating the following categories: low ethnic/low dominant, reference; high ethnic/low dominant; low ethnic/high dominant; and high ethnic/high dominant. STATA (version 12.0; College Station, Texas) was used for all analysis.

3. Results

Analyses were restricted to those with valid values for PA min/week per domain (maximum possible of 960 min/day [16 h/day] of activity) resulting in an analytic sample size of $n = 1772$. The characteristics of the CHA CHA participants with valid reports of PA minutes are displayed in Table 1. The majority of the sample were <65 years of age (77.8%), and had less than a college education (64.6%). Mean ethnic society immersion score was 3.64, while the mean dominant society immersion score was 2.23 (possible range for either score: 1–4); the immersion scores were inversely and weakly correlated ($\rho = -0.11$, $p < 0.001$). The prevalence of meeting PA guidelines was high: 88.5% of participants met requirements for meeting aerobic PA guidelines. Mean total PA across all domains was 375.5 min/week (6.3 h/week) – with the majority of the total contributed by transport-related minutes (62.5%; 234.8 min/week). Occupation- and recreation-related PA contributed 14.7% (55.1 min/week) and 22.8% (85.6 min/week) of total PA minutes/week, respectively. Mean sitting time was 2303 min/week, or 329 min/day (5.5 h/day).

Mean acculturation scores stratified by demographic characteristics are displayed in Table 2. Ethnic society immersion score was higher in those who were 45+ years of age compared to younger adults. Ethnic society immersion score was inversely related to income (i.e., lower income, higher score). Conversely, dominant society immersion score was lower in those 45+ years of age compared to younger adults, and positively related to income. Both dimension scores increased with increasing education, but a dose-response pattern was more apparent with the dominant society immersion score.

In univariable analyses, age was meaningfully associated with patterns in activity behaviors (Table 3). For instance, the prevalence of meeting PA guidelines, total PA min/week, transportation- and recreation-related PA were higher in a dose-response fashion in middle-aged (45–64 years) and older (65+ years) adults compared to younger adults (18–44 years). Occupation-related PA, vigorous PA and sitting times were lower in a similar dose-response fashion with increasing age. Men had more occupation- and recreation-related PA min/week, but less sitting time per week compared to women. In

terms of socioeconomic factors, less sitting time was observed in those with less than a college vs. college degree and in those at lower vs. higher income levels.

Results from multivariable regression models are displayed in Tables 4 and 5. In crude models, a one-unit increase in ethnic society

Table 1
Demographic characteristics of study participants, The Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11.

	n	% or mean
Overall	1772	100
Age group, years of age		
21–44	487	27.5
45–64	892	50.3
65+	393	22.2
Female sex	960	54.2
Education		
Less than high school	24	1.4
Grade 12 or GED	237	13.4
Some college	883	49.8
College graduate	628	35.4
Current household income/year		
$0–9999	586	33.1
$10,000–19,999	525	29.6
$20,000–29,999	297	16.8
$30,000–49,999	206	11.6
$50,000+	158	8.9
Acculturation[a]		
Ethnic society immersion, mean ± SD[b]	1772	3.64 ± 0.26
Dominant society immersion, mean ± SD[b]	1772	2.23 ± 0.59
Activity behaviors		
Meets PA guidelines	1772	88.5
Total PA, minutes/week	1772	375.5 ± 336.6
Work-related PA, minutes/week	1772	55.1 ± 174.4
Transport-related PA, minutes/week	1772	234.8 ± 225.9
Recreation-related PA, minutes/week	1772	85.6 ± 169.1
Sitting time, minutes/day	1772	329.1 ± 174.5

[a] Assessed by the Stephenson Multigroup Acculturation Scale (SMAS); Total possible scores of 4 for ethnic or dominant society immersion.
[b] Correlation between ethnic and dominant society immersion scores: $\rho = -0.11$, $p < 0.001$.

Table 2
Acculturation[a] by demographic characteristics, The Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11.

	Ethnic society immersion, mean ± SD	Dominant society immersion, mean ± SD
Overall	3.64 ± 0.26	2.23 ± 0.59
Age group, years of age		
21–44 (Reference)	3.59 ± 0.01	2.36 ± 0.03
45–64	3.66 ± 0.01***	2.18 ± 0.02***
65+	3.67 ± 0.01***	2.10 ± 0.03***
Sex		
Female (Reference)	3.64 ± 0.01	2.22 ± 0.02
Male	3.64 ± 0.01	2.24 ± 0.02
Education		
Less than High School	3.32 ± 0.09***	1.76 ± 0.09***
Grade 12 or GED	3.60 ± 0.02	1.95 ± 0.03***
Some college	3.63 ± 0.01***	2.14 ± 0.02***
College graduate (Reference)	3.63 ± 0.01	2.48 ± 0.02
Current household income/year		
$0–9999	3.66 ± 0.01***	2.12 ± 0.02***
$10,000–19,999	3.64 ± 0.01***	2.13 ± 0.02***
$20,000–29,999	3.66 ± 0.01**	2.27 ± 0.03***
$30,000–49,999	3.63 ± 0.03	2.47 ± 0.04
$50,000+ (Reference)	3.57 ± 0.03	2.56 ± 0.05

Statistical significance: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, compared to indicated reference group.
[a] Assessed by the Stephenson Multigroup Acculturation Scale (SMAS); Total possible scores of 4 for ethnic or dominant society immersion.

Table 3
Activity behaviors by demographic characteristics, The Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11.

	Meets aerobic physical activity guidelines (%)	Mean physical activity time (minutes/week)						Mean sitting time (minutes/day)
		Total	By domain			By intensity		
			Work-related	Transportation-related	Recreation	Moderate	Vigorous	
Overall	88.5	375.5	55.1	234.8	85.6	344.5	31.0	329.1
Age group, years of age								
21–44 (Reference)	85.4	311.3	62.4	181.2	67.7	275.7	35.5	377.3
45–64	87.7	386.0***	68.5	230.8***	86.6*	351.5***	34.5	312.8***
65 +	94.1***	431.4***	15.8***	310.0***	105.7**	413.8***	17.6*	306.3***
Sex								
Female (Reference)	87.9	346.7	39.6	237.3	69.8	327.9	18.8	341.3
Male	89.2	409.6***	73.5***	231.7	104.4***	364.1*	45.4***	314.6**
Education								
Less than high school	79.2	386.0	57.5	271.0	57.5	358.5	27.5	373.8
Grade 12 or GED	86.5	386.7	40.7	263.6	82.4	368.0	18.7	299.3***
Some college	88.3	378.4	73.2***	228.2	77.0*	342.5	35.9	309.9***
College graduate (Reference)	89.8	366.8	35.1	231.7	100.0	337.9	28.9	365.5
Current household income/year								
$0–9999	88.7	391.7	46.5	261.9	83.3	365.1*	26.7	309.1***
$10,000–19,999	87.6	375.1	58.4	231.3	85.4	343.7	31.4	321.5***
$20,000–29,999	90.2	370.7	70.0	219.4	81.2	333.4	37.3	344.0
$30,000–49,999	84.4*	365.4	58.7	213.5	93.2	330.3	35.4	344.4
$50,000 + (Reference)	92.4	339.2	43.5	202.1	93.6	310.3	28.9	380.0

T-tests for proportions for categorical physical activity variable; t-tests for continuous physical activity variables.
Statistical significance: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, compared to indicated reference group.

immersion was associated with less occupation-related PA (−37.5 min/week, $p = 0.02$), recreation-related PA (−33.9 min/week, $p = 0.03$) and sitting time (−38.2 min/week, $p = 0.02$) and with more transportation-related PA (54.3 min/week, $p = 0.01$; Table 4). After adjustment for age, sex, household income, and education, only the association with recreation-related PA persisted, with a one-unit increase in ethnic society immersion score being associated with 40.7 less minutes/week. In crude models, a one-unit increase in dominant society immersion was associated with a higher odds of meeting PA guidelines (OR: 1.60, 95% CI: 1.23, 2.07; $p < 0.001$; Table 5), with more total PA (26.9 min/week, $p = 0.05$), recreation-related PA (35.2 min/week, $p < 0.001$), and vigorous PA (13.6 min/week, $p = 0.001$). All associations persisted after adjustment. In interaction analyses, having low ethnic and high dominant, vs. low ethnic and low dominant immersion scores was associated with 72.8 (95% CI: 15.8, 129.8, $p = 0.01$) more total PA minutes/week after adjustment for age, sex, income and education (full results not shown). This association was driven primarily by recreation-related PA, with those having low ethnic/high dominant scores having 50.5 (95% CI: 22.0, 79.0, $p = 0.001$) more minutes/week compared to the referent group. No other acculturation score combinations (high ethnic/low dominant; high ethnic/high dominant) or PA outcomes were statistically significant.

4. Discussion

Among a cross-sectional sample of foreign-born Chinese Americans, acculturation across two dimensions was associated with activity behaviors. More specifically, higher personal identification with ethnic (Chinese) society was associated with less recreation-related PA, while higher identification with the dominant (American) society was associated with more recreation-related PA. Interestingly, the amount of more or less PA (~35 min/week) was similar for both dimension.

Numerous studies and reviews have demonstrated that for immigrants acculturation to American society is associated with a worsening of diet, physical activity and subclinical cardiovascular disease, with the evidence being strongest for Hispanics (Perez-Escamilla, 2011; Lutsey et al., 2008; Day et al., 2011; Diez Roux et al., 2005; Kandula et al., 2008; Moran et al., 2007; Gordon-Larsen et al., 2003). A recent review has challenged this assumption among Asian immigrants, citing little to no evidence to support this 'negative acculturation' theory (Ro, 2014). Further complexity is introduced when one considers broader societal and environmental level effects such as residing in an ethnic enclave, which may or may not lead to a preservation of healthy behaviors or offer added social and structural supports (Ro, 2014; Lim et al., 2015; Osypuk et al., 2009; Yi et al., 2014; Zhang et al., 2015). These results

Table 4
Multivariable regression results: Activity behaviors associated with one-unit increase in ethnic society immersion, The Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11.

	Crude			Adjusted		
	Odds ratio or β coefficient	95% CI	p-Value	Odds ratio or β coefficient	95% CI	p-Value
Odds ratio and 95% CI						
Meets aerobic PA guidelines	1.31	(0.76, 2.24)	0.33	1.05	(0.59, 1.88)	0.86
β coefficient and 95% CI						
Total, minutes per week	−17.2	(−78.6, 44.2)	0.58	−43.2	(−106.4, 19.9)	0.18
By domain						
Occupation-related, minutes per week	−37.5	(−69.3, −5.8)	**0.02**	−34.6	(−67.2, −2.1)	**0.04**
Transportation-related, minutes per week	54.3	(13.1, 95.4)	**0.01**	32.1	(−9.8, 74.1)	0.13
Recreation, minutes per week	−33.9	(−64.7, −3.1)	**0.03**	−40.7	(−72.4, −9)	**0.01**
By intensity						
Moderate, minutes per week	4.8	(−51.4, 61)	0.87	−24.4	(−82, 33.2)	0.41
Vigorous, minutes per week	−22.1	(−40.8, −3.2)	**0.02**	−18.8	(−38.1, 0.5)	0.06
Sitting time, minutes per day	−38.2	(−70, −6.4)	**0.02**	−13.8	(−46, 18.3)	0.40

Models adjusted for age, sex, household income, education; adjustment factors were non-collinear.
Bold indicates statistical significance at $p < 0.05$.

Table 5
Multivariable regression results: Activity behaviors associated with one-unit increase in dominant society immersion, The Chinese American Cardiovascular Health Assessment (CHA CHA) 2010–11.

	Crude			Adjusted		
	Odds ratio or β coefficient	95% CI	p-Value	Odds ratio or β coefficient	95% CI	p-Value
Odds ratio and 95% CI						
Meets aerobic PA guidelines	1.60	(1.23, 2.07)	**<0.001**	1.66	(1.25, 2.2)	**<0.001**
β coefficient and 95% CI						
Total, minutes per week	26.9	(0.37, 53.5)	**0.05**	45.4	(16.9, 74)	**0.002**
By domain						
Occupation-related, minutes per week	−4.4	(−18.2, 9.3)	0.53	−7.8	(−22, 6.3)	0.28
Transportation-related, minutes per week	−3.8	(−21.7, 14)	0.67	9.8	(−9.2, 28.8)	0.31
Recreation, minutes per week	35.2	(21.9, 48.4)	**<0.001**	36.5	(22.2, 50.8)	**<0.001**
By intensity						
Moderate, minutes per week	13.0	(−11.3, 37.3)	0.29	30.5	(4.5, 56.6)	**0.02**
Vigorous, minutes per week	13.9	(5.8, 22)	**0.001**	14.9	(6.2, 23.6)	**0.001**
Sitting time, minutes per day	12.3	(−1.4, 26.1)	0.08	−10.0	(−24.6, 4.5)	0.18

Models adjusted for age, sex, household income, education; adjustment factors were non-collinear.
Bold indicates statistical significance at $p < 0.05$.

underscore the need to consider contextual factors including social and cultural norms in respective countries of origin in conducting sub-population research in immigrant communities. A clear and well-documented example of this in the literature is that of smoking in Asian Americans: Chinese American men have a high prevalence of smoking, which decreases with increased acculturation to U.S. society (Li et al., 2013). Conversely Chinese American women have a low prevalence of smoking, which increases with increased acculturation to U.S. society (Li et al., 2013). Looking to data from China, in 2010, 52.9% of men and 2.4% of women smoked (Li et al., 2011). Thus the prevalence of health behaviors in the host country is heavily influenced by prevalence and norms of health behaviors in the native country.

Relatedly in the current analysis, we found that less acculturation (higher ethnic society immersion score) was associated with less recreation-related PA and that more acculturation (higher dominant society immersion score) was associated with more recreation-related PA. Given the low prevalence of recreation-related PA in Chinese adults in China (24.5%) (Muntner et al., 2005) coupled with the low prevalence of PA behaviors demonstrated in Chinese Americans, (Yi et al., 2015) we surmise that PA is not emphasized as a cultural norm in traditional Chinese society. We further conclude that with greater acculturation to U.S. society where increased PA is a societal norm, activity behaviors shift towards increased levels. Thus sweeping beliefs about a unidirectional acculturation theory may not be the best approach.

The conceptualization of acculturation as a two dimensional process (Berry, 1997; Calzada et al., 2012) or as one requiring consideration of interaction between the two dimensions (Berry, 2003) have both been previously applied in the literature. Further, prior studies suggest this processes to be independent of one another in among foreign-born Chinese Americans (Yoo et al., 2013a). While full characterization of these concepts is beyond the scope of our manuscript, we preliminarily explore this in the current analysis. We found that those with low ethnic but high dominant society immersion scores exercised approximately 50 min/week more compared to those with low ethnic and low dominant society scores, suggesting that conceptualization of these as non-independent processes may also be salient in foreign-born Chinese Americans. We are currently exploring these concepts of interaction using linear vs. categorical acculturation measures, and the associations of acculturation with health behaviors (Huang et al., 2016).

The findings of activity behaviors across age groups are of a novel contribution and of note. Analyses in Chinese and Chinese American adults have also demonstrated that unlike in other racial/ethnic groups, PA tends to increase with age, with the oldest adults engaging in the most PA of all age groups (Li et al., 2014; Bauman et al., 2011; Ku et al., 2006). However because their activity levels are already lower than other racial/ethnic groups, this 'increase' with age in fact places Asian American older adults (65 + years) at similar levels of self-

reported activity as their age peers (New York City Department of Health and Mental Hygiene, 2015). In Chinese culture as adults age, value is placed on exercise and physical health, (Belza et al., 2004) though a similar emphasis for younger age groups does not seem apparent. These results highlight the need for intervention and education of the importance of PA in early childhood in Chinese immigrant families, targeted not only at children but across multiple age groups within the family structure (parents, grandparents), and ideally, establishing a new social norm for regularly performing exercise across the life course.

A strength of the current analysis is the presentation of analyses focused on a specific subgroup of Asian Americans and in a large sample size. Asian Americans are often not included in national or regional surveys, and were only recently added to the primary health surveillance dataset, the National Health and Nutrition Examination Survey (NHANES) in the 2011–12 survey wave. The utilization of validated and comprehensive tools for assessment of both the exposure and of the outcomes are an additional strength. The limitations of this analysis include that data were collected via self-report, which may be influenced by social desirability. We were also unable to examine factors of NYC such as enclave residence given the lack of geographic data for participants. However, given the sampling strategy and partner institutions, it is likely that the majority of participants were residing in a NYC Chinese American ethnic enclave (Chinatown or Sunset Park), thus we suspect little variation would have been observed for this particular variable. A substantial number of statistical tests were performed, but given that 2/8 (25%) ethnic society immersion and 5/8 (63%) dominant society immersion multivariable models were significant, it is likely that these analyses reflect true differences, and not results due to chance alone. Lastly, results may not be generalizable to all Chinese American immigrants in NYC or nationally, as Chinese regional and/or country variation in immigration patterns exist across the U.S., with those settling in the NYC area differing from those settling in other parts of the country given the living contexts (e.g., regional differences on resources and opportunities differences for PA) (Yoo et al., 2013b). Also, given this is a community-based sample, estimates in the prevalence or amount of activity behaviors may be biased. Further limiting generalizability, in the current dataset, 66.2% of the sample immigrated after the age of 30 years, which may explain the higher ethnic and lower dominant society immersion observed. However this should not influence internal validity of these study results.

Given the rapid growth of the Chinese American population, the low prevalence of meeting PA guidelines, the increased prevalence of impaired fasting glucose (Rajpathak and Wylie-Rosett, 2011b) and increased concerns around obesity and overweight in Chinese American youth (Au et al., 2009), strategies that target increased PA in this community are warranted. Results from this analysis demonstrate the potential for the critical appraisal of level of acculturation to aid in

intervention delivery, messaging and strategies to improve healthy activity behaviors and increase norms around exercise.

Conflicts of interest

None.

Acknowledgments

References

Afable, K., et al., 2016. Duration of US residence and obesity risk in NYC Chinese immigrants. J. Immigr. Minor. Health 18 (3), 624–635. http://dx.doi.org/10.1007/s10903-015-0216-y (Erratum in: J Immigr Minor Health. 2016 Oct;18(5):1253–1255).

Afable-Munsuz, A., et al., 2010. Immigrant generation and physical activity among Mexican, Chinese & Filipino adults in the U.S. Soc. Sci. Med. 70 (12), 1997–2005.

Artinian, N.T., et al., 2010. Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. Circulation 122 (4), 406–441.

Asian Americans in New York City, 2012. A decade of dynamic change (2000–2010). Asian American Federation Accessed May 18, 2015. Available from http://www.aafederation.org/pdf/AAF_nyc2010report.pdf.

Au, L., et al., 2009. Prevalence of overweight and obesity in Chinese American children in New York City. J. Immigr. Minor. Health 11 (5), 337–341.

Bartley, K., et al., 2013. Physical Activity and Transit Survey: Summary Data. The New York City Department of Health and Mental Hygiene. (Available at) http://www.nyc.gov/html/doh/downloads/pdf/epi/PAT-survey-summary.pdf (Accessed on April 17, 2015).

Bauman, A., et al., 2011. Cross-national comparisons of socioeconomic differences in the prevalence of leisure-time and occupational physical activity, and active commuting in six Asia-Pacific countries. J. Epidemiol. Community Health 65 (1), 35–43.

Belza, B., et al., 2004. Older adult perspectives on physical activity and exercise: voices from multiple cultures. Prev. Chronic Dis. 1 (4), A09.

Berry, J.W., 1997. Immigration, acculturation, and adaptation. Appl. Psychol. 46 (1), 5–34.

Berry, J.W., 2003. Conceptual approaches to acculturation. In: Chun, K.M., Organista, P.B., Marín, G. (Eds.), Acculturation: Advances in Theory, Measurement, and Applied Research. American Psychological Association, Washington, DC, US, pp. 17–37.

Bhattacharya Becerra, M., et al., 2015. Social Determinants of Physical Activity Among Adult Asian-Americans: Results from a Population-Based Survey in California. J. Immigr. Minor. Health 17 (4), 1061–1069. http://dx.doi.org/10.1007/s10903-014-0074-z.

Calzada, E.J., et al., 2012. Test of a cultural framework of parenting with Latino families of young children. Cult. Divers. Ethn. Minor. Psychol. 18 (3), 285–296.

Centers for Disease, C. and Prevention, 2013. Adult participation in aerobic and muscle-strengthening physical activities—United States, 2011. MMWR Morb Mortal Wkly Rep. 62(17), pp. 326–330.

Cleland, C.L., et al., 2014. Validity of the global physical activity questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. BMC Public Health 14, 1255.

Day, E.C., et al., 2011. Associations of acculturation and kidney dysfunction among Hispanics and Chinese from the Multi-Ethnic Study of Atherosclerosis (MESA). Nephrol. Dial. Transplant. 26 (6), 1909–1916.

Deurenberg, P., Deurenberg-Yap, M., Guricci, S., 2002. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. Obes. Rev. 3 (3), 141–146.

Diez Roux, A.V., et al., 2005. Acculturation and socioeconomic position as predictors of coronary calcification in a multiethnic sample. Circulation 112 (11), 1557–1565.

Firestone, M.J., et al., 2015. Perceptions and the role of group exercise among New York City adults. An Examination of Interpersonal Factors and Leisure-Time Physical Activity Preventive Medicine 72, 50–55. http://dx.doi.org/10.1016/j.ypmed.2015.01.001.

Frey, W., 2011. The New Metropolitan Minority Map: Regional Shifts in Hispanics, Asians, and Blacks from Census 2010. http://www.brookings.edu/research/papers/2011/08/31-census-race-frey Metropolitan Policy Program, Brookings.

Gordon-Larsen, P., et al., 2003. Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health. Soc. Sci. Med. 57 (11), 2023–2034.

Ha, A., Macdonald, D., Pang, B., 2010. Physical activity in the lives of Hong Kong Chinese children. Sport Educ. Soc. 15 (3), 331–346.

Hoeffel, E.M., et al., 2012. The Asian Population: 2010 Census Briefs. https://www.census.gov/prod/cen2010/briefs/c2010br-11.pdf (Accessed Jan 9, 2014).

Huang, K.-Y., et al., 2016. Cultural adaptation, parenting and child mental health among asian american immigrant families. Child Psychiatry Hum. Dev. (Under review).

Islam, N.S., et al., 2010. Methodological issues in the collection, analysis, and reporting of granular data in Asian American populations: historical challenges and potential solutions. J. Health Care Poor Underserved 21 (4), 1354–1381.

Kandula, N.R., Lauderdale, D.S., 2005. Leisure time, non-leisure time, and occupational physical activity in Asian Americans. Ann. Epidemiol. 15 (4), 257–265.

Kandula, N.R., et al., 2008. Association of acculturation levels and prevalence of diabetes in the multi-ethnic study of atherosclerosis (MESA). Diabetes Care 31 (8), 1621–1628.

Kay, M.C., et al., 2014. Awareness and knowledge of the 2008 physical activity guidelines for Americans. J. Phys. Act. Health 11 (4), 693–698.

Ku, P.W., et al., 2006. Prevalence of leisure-time physical activity in Taiwanese adults: results of four national surveys, 2000–2004. Prev. Med. 43 (6), 454–457.

Li, K., Wen, M., 2013. Racial and ethnic disparities in leisure-time physical activity in California: patterns and mechanisms. Race Soc. Probl. 5 (3), 147–156.

Li, Q., Hsia, J., Yang, G., 2011. Prevalence of smoking in China in 2010. N. Engl. J. Med. 364 (25), 2469–2470.

Li, S., et al., 2013. Smoking among Asian Americans: acculturation and gender in the context of tobacco control policies in New York City. Health Promot. Pract. 14 (5 Suppl), 18S–28S.

Li, Y., Kao, D., Dinh, T.Q., 2014. Correlates of neighborhood environment with walking among older Asian Americans. J. Aging Health.

Lim, S., et al., 2015. Defining ethnic enclave and its associations with self-reported health outcomes among Asian American adults in New York City. J. Immigr. Minor Health.

Lutsey, P.L., et al., 2008. Associations of acculturation and socioeconomic status with subclinical cardiovascular disease in the multi-ethnic study of atherosclerosis. Am. J. Public Health 98 (11), 1963–1970.

Maxwell, A.E., et al., 2012. Health risk behaviors among five Asian American subgroups in California: identifying intervention priorities. J. Immigr. Minor. Health 14 (5), 890–894.

Moran, A., et al., 2007. Acculturation is associated with hypertension in a multiethnic sample. Am. J. Hypertens. 20 (4), 354–363.

Muntner, P., et al., 2005. Prevalence of physical activity among Chinese adults: results from the international collaborative study of cardiovascular disease in Asia. Am. J. Public Health 95 (9), 1631–1636.

New York City Department of Health and Mental Hygiene, 2015. (Available from: Epiquery: NYC Interactive Health Data System - Community Health Survey 2013) http://nyc.gov/health/epiquery.

Ogden, C.L., et al., 2014. Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA 311 (8), 806–814.

Osypuk, T.L., et al., 2009. Are immigrant enclaves healthy places to live? The multi-ethnic study of atherosclerosis. Soc. Sci. Med. 69 (1), 110–120.

Perez-Escamilla, R., 2011. Acculturation, nutrition, and health disparities in Latinos. Am. J. Clin. Nutr. 93 (5), 1163S–1167S.

Pew Research Center, 2012. (Available from: The Rise of Asian Americans) http://www.pewsocialtrends.org/2012/06/19/the-rise-of-asian-americans/.

Rajpathak, S.N., Wylie-Rosett, J., 2011a. High prevalence of diabetes and impaired fasting glucose among Chinese immigrants in New York City. J. Immigr. Minor. Health 13 (1), 181–183. http://dx.doi.org/10.1007/s10903-010-9356-2.

Rajpathak, S.N., Wylie-Rosett, J., 2011b. High prevalence of diabetes and impaired fasting glucose among Chinese immigrants in New York City. J. Immigr. Minor. Health 13 (1), 181–183.

Ro, A., 2014. The longer you stay, the worse your health? A critical review of the negative acculturation theory among Asian immigrants. Int. J. Environ. Res. Public Health 11 (8), 8038–8057.

Stephenson, M., 2000. Development and validation of the Stephenson Multigroup acculturation scale (SMAS). Psychol. Assess. 12 (1), 77–88.

Tseng, M., Hernandez, T., 2005. Comparison of intakes of US Chinese women based on food frequency and 24-hour recall data. J. Am. Diet. Assoc. 105 (7), 1145–1148.

United States Department of Health & Human Services, 2008. June 24, 2014]; Available from: 2008 Physical Activity Guidelines for Americans. http://www.health.gov/paguidelines/pdf/paguide.pdf.

Wong, R.J., et al., 2014. Ethnic disparities in the association of body mass index with the risk of hypertension and diabetes. J. Community Health 39 (3), 437–445.

World Health Organization, 2014. June 24, 2014]; Available from: Global Physical Activity Questionnaire (GPAQ) Analysis Guide. Surveillance and Population-Based Prevention, Prevention of Noncommunicable Diseases Department http://www.who.int/chp/steps/resources/GPAQ_Analysis_Guide.pdf.

Yi, S.S., et al., 2014. Racial/ethnic residential segregation, neighborhood poverty and urinary biomarkers of diet in New York City adults. Soc. Sci. Med. 122, 122–129.

Yi, S.S., et al., 2015. Disparities in meeting physical activity guidelines for Asian Americans in two metropolitan areas in the United States. Ann. Epidemiol. 25 (9), 656–660.e2. http://dx.doi.org/10.1016/j.annepidem.2015.05.002.

Yoo, G.J., Le, M.-N., Oda, A.Y., 2013a. Handbook of Asian American health, Chapter 11: Acculturation and Culture: A Critical Factor for Asian Americans' Health. Springer, New York, p. xvi (449 p).

Yoo, G.J., Le, M.-N., Oda, A.Y., 2013b. Handbook of Asian American health, Chapter 3: Chinese Americans and Health: the Impact of Culture on Disease Prevention and Management. Springer, New York, p. xvi (449 p).

Zhang, D., et al., 2015. Does neighbourhood composition modify the association between acculturation and unhealthy dietary behaviours? J. Epidemiol. Community Health 69 (8), 724–731.

Zhou, N., Cheah, C.S., 2015. Ecological risk model of childhood obesity in Chinese immigrant children. Appetite 90, 99–107.