BMJ Open Acculturation, sociodemographic and lifestyle factors associated with compliance with physical activity recommendations in the Mexican-American *Mano A Mano* cohort

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ABSTRACT

Objectives: Being physically active is important for health, and few Mexican-Americans meet national US physical activity recommendations. The aim of this study was to investigate sociodemographic, acculturation and lifestyle factors that were associated with meeting physical activity recommendations in this group.

Design and setting: A cross-sectional analysis of a large population-based cohort study in southern Texas, USA.

Participants: Between 2001 and 2011, 21 551 adult members of the Mexican-American *Mano A Mano* cohort completed baseline questionnaires on physical activity and other lifestyle factors.

Outcomes: Meeting US physical activity recommendations was defined as participating in 150 min of moderate, or 75 min of vigorous, activity per week. Factors contributing to the likelihood of meeting physical activity recommendations were examined by sex and country of birth in multivariate logistic regression models.

Results: Less than half of all men and less than a quarter of all women met US physical activity recommendations. Having some college education, greater acculturation and current alcohol use were each associated with greater odds of meeting physical activity recommendations in all groups except US-born men. Higher body mass index was associated with lower odds of meeting recommendations in US-born and Mexico-born women.

Conclusions: Results demonstrate that factors associated with meeting physical activity recommendations differ by sex and country of birth. Tailored interventions to increase Mexican-Americans' activity levels to achieve health benefits should consider education, acculturation and alcohol use.

INTRODUCTION

The Hispanic population is the largest ethnic group in the USA and is expected to triple in size by the year 2050.¹ This population

Strengths and limitations of this study

- This study employed a large sample of urban-dwelling Mexican-origin adults in the USA.
- The study included detailed measures of physical activity, socio-demographic and lifestyle factors, and acculturation.
- Data from this study are from a period of 11 years of data collection and findings are stratified by gender and place of birth.
- The sample was fairly homogeneous which limits generalisability.
- The cross-sectional design limits the ability to draw causal inferences.

suffers a disproportionate burden of health problems, including obesity and diabetes,^{2 3} while also engaging in less physical activity (PA).⁴ Health outcomes and behaviours vary among different Hispanic subgroups,⁵ and therefore programmes and interventions should be tailored for each specific subgroup.^{4 6} The growth of the US Hispanic population and the Mexican-origin subgroup provided motivation for the development of the population-based Mexican-American *Mano A Mano* cohort study to examine genetics, environmental exposures, lifestyle, and health behaviours, including PA, as they relate to disease incidence and mortality in this dynamic population.⁷

PA benefits are well-established and include lower risk of premature death, heart disease, stroke, type 2 diabetes and some cancers.⁸ Current US recommendations suggest that adults achieve at least 150 min of moderate or 75 min of vigorous activity per week (or an equivalent combination of both).⁸ Although studies show that Mexican-Americans are the most active among Hispanic subgroups in the USA, few

Mexican-Americans meet US national PA recommendations.⁴

Limited research has shown that being male, younger, highly acculturated, and a second-generation immigrant are positively associated with self-reported PA in Mexican-Americans;^{9–11} however, no studies have reported how lifestyle factors, such as alcohol use and smoking, may be related to meeting US national PA recommendations in this population. Although the prevalence of smoking and alcohol use is lower in Hispanic adults compared to Caucasians,¹² studies are needed to determine the associations of those lifestyle choices with other health behaviours in minority populations, as well as how they differ by sex and country of birth. Identifying these associations in high-risk Mexican-Americans will be critical for developing tailored programmes and interventions to effectively increase the proportion meeting US PA recommendations.

Taking these issues into account, we investigated the sociodemographic, acculturation and lifestyle factors associated with meeting PA recommendations in a unique cohort of underserved Mexican-Americans. We further considered how these associations differed in men and women born in the US versus Mexico.

METHODS

Baseline data were analysed from adult participants of the *Mano A Mano* cohort, a large ongoing research study that began in 2001. The study prospectively examines a multitude of factors that may affect mortality and disease incidence in Mexican-Americans residing in the Houston, Texas metropolitan area. Details of the cohort are described elsewhere.⁷ Briefly, adult participants of self-reported Mexican-origin who had resided in the Houston, Texas metropolitan area for at least 1 year were recruited at neighbourhood libraries, community centres, health fairs and clinics and other neighbourhood facilities and events in order to obtain a representative sample. At the scheduled interview appointment, a written informed consent was obtained by a bilingual interviewer before administering the face-to-face interview and collecting the biological samples. Baseline data collection spans a range of social and health characteristics and trained interviewers administer questionnaires in the participants' homes in their preferred language (English or Spanish). The data used in this study were collected at entry into the cohort from participants recruited during 2001–2011. The cohort study was approved by the Institutional Review Boards at The University of Texas MD Anderson Cancer Center.

Measures

Demographics

Demographic characteristics assessed at baseline included age, sex, marital status and education. Age was placed into five categories (<30, 31–40, 41–50, 51–60,

61+) to account for the potential non-linear relationship with PA.¹³ Marital status was dichotomised into married or not married. Education was grouped into three categories (middle school or less, some high school/high school graduate/GED, and some college or technical training and beyond). Body mass index (BMI) was calculated from measured height and weight, and placed into categories of normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9) and obese (BMI 30.0 or greater; class I=30.0–34.9; class II=35.0–39.9; class III=40.0 or greater).¹⁴ Occupation data were collected on a subset of participants (during the years 2004–2011), and participants provided information on the job they have held for the longest time. Responses were then placed into 1 of 23 categories based on the American Time Use Survey (ATUS).¹⁵ These categories have been assigned metabolic equivalent values (METs, the ratio of energy expended in an activity vs energy expended at rest), and the occupations were further ranked as low active (<3.0 METs) or high active (≥3.0 METs).

Acculturation

Degree of acculturation was assessed using the Bi-dimensional Acculturation Scale for Hispanics.¹⁶ Designed for use among all Hispanic groups, it measures linguistic preference when speaking, watching TV, listening to the radio and reading. Responses are made on a four-point scale and averaged to create a mean acculturation score ranging from 1 to 4, which is further dichotomised into less than or greater than 2.5, with scores of ≥2.5 reflecting a preference for, and fluency in English and a high degree of acculturation. This scale has been validated and shown to have good internal reliability among Mexican-Americans.¹⁷

Lifestyle factors

Smoking behaviour was assessed by asking participants if they had smoked ≥100 cigarettes in their lifetime and if they currently smoked. They were then categorised as current, former or never-smokers. Participants were also asked if they had consumed any alcoholic beverages at least once a month for the past year or more and continued consuming alcohol as of the time of the interview. They were then categorised as current, former or never-alcohol drinkers.

Physical activity

PA was assessed using an instrument that has been used in the California Teachers Study (CTS) survey.¹⁸ This instrument can be used to assess PA across the lifespan but the version used in our cohort was adapted specifically to capture usual PA during the past year. Assisted by a trained interviewer, participants estimated the average hours per week and the average number of months during the past year they spent in exercise, sport or work activities of strenuous, moderate and light intensities. Average hours per week were reported in categories of never, 0.5, 1, 1.5, 2, 3, 4–6, 7–10 and 11 or more

hours, and the average number of months was reported in categories of 1–3, 4–6, 7–9 and 10–12 months. Participants were also asked to report average hours spent sitting and sleeping per day. Sitting time was dichotomised as 0–3 h and more than 3 h of sitting per day, in accordance with the literature.¹⁹

Separate hours per week variables were calculated for strenuous, moderate and light PA by multiplying the number of hours spent per week by the portion of the year in which they engaged in activity at those intensities. The median value of the categories was used in these calculations (eg, 5 h was chosen for the category of 4–6 h) in accordance with published methods.¹⁸ Hours per week of strenuous and moderate activity were then summed together and converted to minutes per week for calculating whether participants met the national PA recommendations previously described.

Data analysis

Distributions and frequency data were examined for all variables for men and women separately. Cases with missing data were excluded pairwise; the numbers of cases with missing data were as follows: birthplace=26; education=12; acculturation=60; BMI=222; alcohol use=503; smoking=242; sitting=23; sleep=28; and PA=28. Demographic, acculturation and lifestyle factors were compared using χ^2 analyses for categorical variables and one-way analysis of variance for continuous variables. Age-adjusted ORs were calculated individually from other factors, which was then followed by conducting multivariate logistic regression analyses to examine factors associated with odds of meeting activity recommendations. This approach was used to show how the associations changed with the addition of multiple variables. Trends for categorical variables with more than two levels were examined using the linear-by-linear association statistic. Multicollinearity was checked using the Variance Inflation Factor. We also examined if there were differences among all variables by the year of entry into our study. All analyses were conducted using SAS V.9.3 (SAS Institute, Cary, North Carolina, USA), and a two-sided α level of $p < 0.05$ was considered statistically significant.

RESULTS

Study participants comprised 21 551 adults who were predominantly female (78.0%), born in Mexico (73.2%), overweight or obese (81.2% with BMI over 25 kg/m²), and with high school education or less (81.8%). Overall, 4790 (22.2%) participants reported being a current drinker, with a higher percentage of males than females reporting this (52.7% vs 14.5%); and 2449 (12.3%) participants reported being a current smoker, with a higher percentage of males than females reporting this (26.1% vs 8.6%, respectively). Compared to all Hispanics in the State of Texas, there were more overweight or obese individuals (81.2% vs 65.1%), and a

lower percentage of current drinkers (22.2% vs 49.3%) and current smokers (12.3% vs 16%) in our cohort.^{20–22} The most commonly reported occupation categories were housewife, cleaning and maintenance, food preparation and serving, and construction/extraction occupations. A total of 5347 (24.8%) of all participants met US national PA recommendations.

No evidence of multicollinearity was found, and there were no differences by year of entry into our study. Initial analyses showed interaction between sex and country of birth, and future analyses were subsequently stratified on those variables. Characteristics of the study participants are summarised in [table 1](#). Compared to US-born participants, those born in Mexico were more likely to be married and have a high active job. Additionally, Mexico-born men were more likely than Mexico-born women to have a high active job. Mexico-born women were least likely to smoke or drink alcohol, and were also least likely to meet PA recommendations. Participants born in the USA were more likely than Mexico-born participants to have more education and a higher acculturation score, while also having a higher BMI and sitting more hours per day. Regardless of country of birth, men reported more hours of strenuous PA and women reported more hours of light and total PA.

Characteristics for US-born participants and for Mexico-born participants meeting and not meeting PA recommendations are shown in [table 2](#). For Mexico-born participants only, having a more active occupation, being a current smoker and sitting 3 h or fewer per day were associated with meeting recommendations; whereas for US-born only, being not married was associated with meeting recommendations. Additionally, regardless of place of birth, more men met recommendations than women. Meeting PA recommendations was associated with higher levels of education, higher acculturation scores, lower BMI and current alcohol consumption. Furthermore, those meeting recommendations reported more hours of strenuous, moderate and total activity per week, while those not meeting recommendations reported more light hours per week. Those meeting recommendations also reported slightly fewer hours of sitting time per week than those not meeting recommendations.

[Table 3](#) shows age-adjusted ORs for meeting PA recommendations for each sex and country of birth group. For all groups, a higher acculturation score was associated with greater odds of meeting PA recommendations. Among both Mexico-born and US-born women, being not married and current alcohol consumption were associated with higher odds of meeting PA recommendations, whereas a higher BMI was associated with lower odds of meeting recommendations.

Sex-specific and country of birth-specific multivariate logistic regression analyses revealed some group differences among factors associated with meeting PA

Table 1 Socioemographic, acculturation, and lifestyle characteristics of *Mano A Mano* study participants (n=21 551) by gender and birthplace

Variable	Mexico-born males N (%), or mean (±SD)	Mexico-born females N (%), or mean (±SD)	US-born males N (%), or mean (±SD)	US-born females N (%), or mean (±SD)
Number of participants (%)	3237 (20.5)	12 542 (79.5)	1470 (25.6)	4271 (74.4)
Mean Age (years)*†	41.98 (±14.1)	39.16 (±12.6)	42.02 (±17.6)	40.75 (±16.8)
Years in USA*†	17.9 (±12.5)	14.6 (±10.7)	40.4 (±17.9)	39.1 (±17.2)
Marital status*†				
Married	2850 (88.1)	10 150 (81.1)	972 (66.3)	2497 (58.5)
Not married	384 (11.9)	2368 (18.9)	495 (33.7)	1771 (41.5)
Education				
Middle school or less	1263 (39.1)	4954 (39.5)	221 (15.0)	705 (16.5)
Some high school, HS graduate or GED	1443 (44.6)	5652 (45.1)	871 (59.3)	2487 (58.3)
Some college and beyond	528 (16.3)	1929 (15.4)	378 (25.7)	1077 (25.2)
Occupation*†				
Missing	1926 (59.5)	6810 (54.3)	1114 (75.8)	3145 (73.6)
Low active	313 (9.7)	4003 (31.9)	160 (10.9)	903 (21.1)
High active	998 (30.8)	1729 (13.8)	196 (13.3)	223 (5.2)
Acculturation*				
<2.5	2086 (64.6)	9854 (78.8)	117 (8.0)	406 (9.5)
≥2.5	1143 (35.4)	2655 (21.2)	1350 (92.0)	3849 (90.5)
BMI*†				
Mean (kg/m ²)	29.2 (±5.1)	30.4 (±6.4)	30.9 (±6.6)	32.4 (±8.1)
Normal	571 (17.8)	2170 (17.7)	221 (15.1)	662 (15.7)
Overweight	1426 (44.5)	4216 (34.3)	508 (34.7)	1090 (25.9)
Obese (class I)	864 (27.0)	3404 (27.7)	394 (26.9)	1106 (26.3)
Obese (class II)	237 (7.4)	1591 (12.9)	201 (13.7)	653 (15.5)
Obese (class III)	103 (3.2)	913 (5.9)	138 (9.4)	699 (16.6)
Drink alcohol*†				
Never	782 (24.6)	10 564 (85.2)	334 (24.4)	2454 (60.2)
Quit	711 (22.4)	555 (4.5)	322 (23.5)	516 (12.7)
Current	1683 (53.0)	1277 (10.3)	714 (52.1)	1105 (27.1)
Smoke*†				
Never	1467 (45.6)	10 614 (85.0)	590 (41.8)	2891 (69.4)
Quit	963 (30.0)	1086 (8.7)	399 (28.3)	622 (14.9)
Current	785 (24.4)	786 (6.3)	422 (29.9)	653 (15.7)
PA				
Meeting PA rec's*†	1446 (45.4)	2339 (18.9)	613 (42.5)	949 (22.6)
Not meeting PA rec's	1737 (54.6)	10 013 (81.1)	830 (57.5)	3250 (77.4)
Strenuous hours/year*†	106.5 (±199.2)	12.4 (±62.9)	77.9 (±169.5)	17.6 (±76.4)
Moderate hours/year*†	73.1 (±158.3)	35.5 (±103.6)	75.5 (±155.9)	42.3 (±113.3)
Light hours/year*†	152.4 (±209.4)	312.6 (±219.0)	157.9 (±208.6)	276.9 (±222.8)
Total hours/year*†	331.9 (±301.5)	360.6 (±246.9)	311.2 (±307.1)	336.9 (±258.3)
Sitting and sleeping				
Sitting hours/day*†	3.6 (±2.5)	3.3 (±2.1)	4.9 (±3.3)	4.7 (±3.0)
3 h or less	2355 (20.3)	9236 (79.7)	733 (25.4)	2148 (74.6)
More than 3 h	879 (21.1)	3293 (78.9)	735 (25.8)	2119 (74.2)
Sleep (h/day)*				
<5	272 (8.4)	955 (7.6)	185 (12.6)	509 (11.9)
6	590 (18.2)	2048 (16.4)	320 (21.8)	894 (21.0)
7	828 (25.6)	2719 (21.7)	295 (20.1)	860 (20.2)
8	1281 (39.6)	5209 (41.6)	485 (33.0)	1432 (33.6)
9	177 (5.5)	930 (7.4)	99 (6.7)	314 (7.4)
≥10	85 (2.6)	664 (5.3)	84 (5.7)	257 (6.0)

*p<0.05 between Mexican-born males and females.

†p<0.05 between US-born males and females.

BMI, body mass index; PA rec's, physical activity recommendations.

Table 2 Associations* of sociodemographic, acculturation and lifestyle variables with meeting national PA recommendations by birthplace among the Mexican-American *Mano A Mano* cohort, 2001–2011

Variable	Mexico-born		p Value	US-born		p Value
	% Meeting rec	% Not meeting rec		% Meeting rec	% Not meeting rec	
Male	1446 (45.4)	1737 (54.6)	<0.0001	613 (42.5)	830 (57.5)	<0.0001
Female	2339 (18.9)	10 013 (81.1)		949 (22.6)	3250 (77.4)	
Marital status						
Married	3128 (24.4)	9673 (75.6)	.359	901 (26.3)	2520 (73.7)	0.003
Not married	652 (24.1)	2055 (75.9)		658 (29.7)	1557 (70.3)	
Education						
Middle school or less	1174 (19.1)	4959 (80.9)	<0.0001	164 (17.9)	751 (82.1)	<0.0001
Some high school, HS graduate or GED	1858 (26.6)	5134 (73.4)		885 (26.9)	2410 (73.1)	
Some college and beyond	749 (31.2)	1651 (68.8)		513 (35.9)	917 (64.1)	
Occupation						
Low active	812 (19.1)	3435 (80.9)	<0.0001	285 (27.3)	759 (72.7)	0.063
High active	811 (30.3)	1868 (69.7)		132 (32.2)	278 (67.8)	
Acculturation						
<2.5	2440 (20.8)	9316 (79.2)	<0.0001	78 (15.1)	440 (84.9)	<0.0001
≥2.5	1334 (35.7)	2406 (64.3)		1480 (29.0)	3628 (71.0)	
BMI						
Mean (kg/m ²)	29.2 (±5.6)	30.4 (±6.3)	<0.0001	30.9 (±7.0)	32.5 (±7.9)	<0.0001
Normal	756 (27.9)	1949 (72.1)	<0.0001	289 (33.4)	576 (66.6)	<0.0001
Overweight	1510 (27.2)	4037 (72.8)		487 (31.1)	1081 (68.9)	
Obese (class I)	984 (23.4)	3229 (76.6)		398 (27.0)	1077 (73.0)	
Obese (class II)	323 (18.0)	1473 (82.0)		203 (24.1)	639 (75.9)	
Obese (class III)	159 (16.0)	835 (84.0)		172 (20.9)	651 (79.1)	
Drink alcohol						
Never	2189 (19.6)	8975 (80.4)	<0.0001	626 (22.8)	2114 (77.20)	<0.0001
Quit	419 (33.5)	832 (66.5)		200 (24.3)	622 (75.7)	
Current	1116 (38.3)	1800 (61.7)		613 (34.3)	1174 (65.7)	
Smoke						
Never	2640 (22.2)	9254 (77.8)	<0.0001	890 (26.0)	2528 (74.0)	0.055
Quit	622 (30.9)	1391 (69.1)		287 (28.7)	714 (71.3)	
Current	505 (32.6)	1046 (67.4)		311 (29.3)	750 (70.7)	
PA/sedentary time						
Strenuous hours/year	127.6 (±198.1)	0.2 (±2.7)	<0.0001	117.2 (±186.1)	0.34 (±3.3)	<0.0001
Moderate hours/year	168.9 (±189.6)	3.0 (±14.1)	<0.0001	174.5 (±190.6)	3.8 (±15.8)	<0.0001
Light hours/year	223.0 (±232.9)	298 (±221.6)	<0.0001	196.6 (±223.1)	265.1 (±223.4)	<0.0001
Total hours/year	519.5 (±296.7)	301.5 (±221.0)	<0.0001	488.3 (±318.7)	269.3 (±222.9)	<0.0001
Mean sitting hours/day	3.3 (±2.0)	3.4 (±2.2)	<0.0001	4.6 (±2.9)	4.8 (±3.2)	0.05
3 h or less	2848 (25.0)	8565 (75.0)	0.003	808 (28.6)	2016 (71.4)	0.064
More than 3 h	935 (22.7)	3175 (77.3)		753 (26.8)	2061 (73.2)	
Sleep (h/day)						
<5	276 (22.7)	940 (77.3)	<0.0001	182 (26.6)	503 (73.4)	0.002
6	662 (25.6)	1926 (74.4)		351 (29.4)	842 (70.6)	
7	938 (26.8)	2566 (73.2)		346 (30.7)	780 (69.3)	
8	1522 (23.9)	4852 (76.1)		503 (26.6)	1389 (73.4)	
9	244 (22.3)	848 (77.7)		112 (27.4)	297 (72.6)	
≥10	139 (18.7)	604 (81.3)		66 (19.9)	265 (80.1)	

* χ^2 Or t test as appropriate.

BMI, body mass index; PA, physical activity; rec, national physical activity recommendations.

recommendations (table 4). The likelihood of meeting PA recommendations decreased as age increased, with particularly steep decreases among men. The likelihood of meeting recommendations also generally increased with a higher level of education and a higher

acculturation score, regardless of gender and place of birth. In contrast, BMI was significantly associated with lower odds of meeting recommendations. This was particularly prominent among women, who had approximately 50% lower odds among those with class III

Table 3 Age-adjusted ORs (95% CI) of sociodemographic, acculturation and lifestyle variables and meeting PA recommendations in male and female Mexican-American *Mano A Mano* cohort participants by gender and birthplace, 2001–2011

Variable	Mexico-born		US-born	
	Males OR (95% CI)	Females OR (95% CI)	Males OR (95% CI)	Females OR (95% CI)
Marital status				
Married	1.00	1.00	1.00	1.00
Not married	1.16 (0.92 to 1.45)	1.17 (1.04 to 1.31)	1.08 (0.85 to 1.37)	1.29 (1.11 to 1.50)
Education				
Middle school or less	1.00	1.00	1.00	1.00
High school graduate or GED	1.40 (1.18 to 1.65)	1.42 (1.27 to 1.58)	1.01 (0.70 to 1.44)	1.47 (1.15 to 1.89)
Some college and beyond	1.35 (1.09 to 1.68)	2.03 (1.78 to 2.32)	1.50 (1.02 to 2.22)	2.32 (1.78 to 3.02)
Occupation				
Low active	1.00	1.00	1.00	1.00
High active	1.16 (0.89 to 1.51)	1.26 (1.09 to 1.46)	1.41 (0.90 to 2.19)	0.83 (0.57 to 1.20)
Acculturation				
Acculturation score<2.5	1.00	1.00	1.00	1.00
Acculturation score≥2.5	1.47 (1.27 to 1.71)	1.98 (1.79 to 2.19)	1.64 (1.03 to 2.61)	2.19 (1.60 to 3.01)
BMI				
Normal	1.00	1.00	1.00	1.00
Overweight	1.13 (0.92 to 1.38)	0.87 (0.76 to 0.98)	1.13 (0.70 to 1.33)	0.83 (0.67 to 1.04)
Obese I	1.08 (0.87 to 1.34)	0.72 (0.63 to 0.82)	0.98 (0.69 to 1.39)	0.70 (0.56 to 0.88)
Obese II	0.81 (0.59 to 1.11)	0.58 (0.49 to 0.69)	0.75 (0.50 to 1.13)	0.63 (0.49 to 0.82)
Obese III	0.92 (0.59 to 1.42)	0.50 (0.40 to 0.63)	0.91 (0.58 to 1.41)	0.48 (0.36 to 0.62)
Alcohol status				
Never	1.00	1.00	1.00	1.00
Quit	1.16 (0.94 to 1.44)	1.51 (1.24 to 1.85)	0.89 (0.64 to 1.26)	1.01 (0.79 to 1.29)
Current	1.26 (1.06 to 1.51)	1.40 (1.21 to 1.60)	0.90 (0.68 to 1.18)	1.52 (1.29 to 1.80)
Smoke status				
Never	1.00	1.00	1.00	1.00
Quit	1.09 (0.91 to 1.29)	1.10 (0.94 to 1.29)	0.99 (0.75 to 1.31)	1.17 (0.95 to 1.45)
Current	0.95 (0.79 to 1.14)	1.04 (0.86 to 1.25)	0.75 (0.57 to 0.98)	1.05 (0.85 to 1.29)
Sitting time				
3 h or less/day	1.00	1.00	1.00	1.00
More than 3 h/day	0.89 (0.76 to 1.04)	0.95 (0.86 to 1.05)	1.06 (0.85 to 1.33)	0.88 (0.76 to 1.03)
Sleep (h/day)				
<5	1.00	1.00	1.00	1.00
6	1.13 (0.84 to 0.52)	1.14 (0.93 to 1.40)	0.91 (0.62 to 1.33)	1.22 (0.94 to 1.60)
7	1.16 (0.88 to 1.54)	1.20 (0.99 to 1.45)	1.03 (0.70 to 1.52)	1.24 (0.95 to 1.62)
8	1.08 (0.82 to 1.41)	1.06 (0.88 to 1.27)	0.80 (0.56 to 1.15)	1.04 (0.80 to 1.33)
9	0.97 (0.65 to 1.45)	1.06 (0.84 to 1.35)	0.81 (0.47 to 1.37)	1.10 (0.78 to 1.56)
≥10	0.75 (0.45 to 1.26)	0.93 (0.71 to 1.21)	0.64 (0.37 to 1.10)	0.63 (0.41 to 0.95)

BMI, body mass index.

obesity, regardless whether the women were born in Mexico (OR=0.51; 95% CI 0.41 to 0.64) or the USA (OR=0.47; 95%CI 0.36 to 0.63). Among all groups except for US-born men, current alcohol consumption was significantly associated with greater odds of meeting recommendations. Lastly, in US-born women only, getting 10 or more hours of sleep (OR=0.61; 95% CI 0.40 to 0.95) and sitting more than 3 h per day (OR=0.81; 95% CI 0.69 to 0.96) were associated with reduced odds of meeting recommendations. Additional adjustment for physically active occupation (high vs low), which was available in a subset of participants, did not meaningfully change the results presented (data not shown).

DISCUSSION

In this study, we found that being more acculturated, having some college education and current alcohol consumption were associated with higher odds of meeting PA recommendations in all women and Mexico-born men. In US-born and Mexico-born women, a higher BMI was associated with lower odds of meeting recommendations. Public efforts to increase the proportion of Mexican-Americans meeting PA recommendations should consider gender and country of birth, as well as level of acculturation and other health-related behaviours when designing culturally-tailored programmes and interventions for this population.

Table 4 Multivariate adjusted ORs (95% CI) of sociodemographic, acculturation and lifestyle variables and meeting PA recommendations in Mexican-American *Mano A Mano* cohort participants by gender and birthplace, 2001–2011

Variable	Mexico-born		US-born	
	Males OR (95% CI)	Females OR (95% CI)	Males OR (95% CI)	Females OR (95% CI)
Marital status				
Married	1.00	1.00	1.00	1.00
Not married	1.18 (0.92 to 1.51)	1.01 (0.89 to 1.15)	1.01 (0.78 to 1.30)	1.14 (0.97 to 1.33)
Age*				
<30	1.00	1.00	1.00	1.00
31–40	0.85 (0.69 to 1.05)	1.06 (0.94 to 1.20)	0.78 (0.56 to 1.08)	0.99 (0.80 to 1.22)
41–50	0.59 (0.47 to 0.75)	1.16 (1.01 to 1.33)	0.53 (0.37 to 0.75)	0.90 (0.71 to 1.14)
51–60	0.50 (0.38 to 0.65)	0.99 (0.83 to 1.19)	0.37 (0.25 to 0.55)	0.59 (0.45 to 0.78)
61+	0.33 (0.25 to 0.45)	0.89 (0.71 to 1.12)	0.26 (0.18 to 0.39)	0.70 (0.53 to 0.92)
Education				
Middle school or less	1.00	1.00	1.00	1.00
High school graduate or GED	1.28 (1.07 to 1.53)	1.24 (1.11 to 1.39)	0.90 (0.62 to 1.31)	1.26 (0.97 to 1.63)
Some college and beyond	1.17 (0.93 to 1.47)	1.67 (1.45 to 1.92)	1.22 (0.80 to 1.85)	1.85 (1.40 to 2.45)
Acculturation				
Acculturation score<2.5	1.00	1.00	1.00	1.00
Acculturation score≥2.5	1.42 (1.21 to 1.68)	1.77 (1.59 to 1.97)	1.55 (0.96 to 2.51)	1.82 (1.31 to 2.54)
BMI*				
Normal	1.00	1.00	1.00	1.00
Overweight	1.04 (0.85 to 1.29)	0.91 (0.80 to 1.04)	1.12 (0.78 to 1.62)	0.81 (0.64 to 1.02)
Obese I	1.02 (0.82 to 1.28)	0.77 (0.67 to 0.88)	0.94 (0.64 to 1.38)	0.68 (0.54 to 0.87)
Obese II	0.77 (0.55 to 1.06)	0.60 (0.51 to 0.72)	0.78 (0.50 to 1.22)	0.60 (0.45 to 0.79)
Obese III	0.85 (0.54 to 1.33)	0.51 (0.41 to 0.64)	0.85 (0.52 to 1.39)	0.47 (0.36 to 0.63)
Alcohol status*				
Never	1.00	1.00	1.00	1.00
Quit	1.21 (0.96 to 1.51)	1.52 (1.23 to 1.88)	0.94 (0.66 to 1.35)	0.97 (0.75 to 1.26)
Current	1.31 (1.09 to 1.58)	1.28 (1.10 to 1.48)	0.91 (0.69 to 1.22)	1.35 (1.13 to 1.62)
Smoke status*				
Never	1.00	1.00	1.00	1.00
Quit	1.06 (0.89 to 1.27)	0.94 (0.79 to 1.11)	1.01 (0.74 to 1.36)	1.18 (0.94 to 1.48)
Current	0.92 (0.76 to 1.12)	0.89 (0.74 to 1.09)	0.76 (0.57 to 1.01)	0.97 (0.77 to 1.22)
Sitting time				
3 h or less/day	1.00	1.00	1.00	1.00
More than 3 h/day	0.87 (0.74 to 1.02)	0.95 (0.86 to 1.06)	1.03 (0.81 to 1.31)	0.81 (0.69 to 0.96)
Sleep (h/day)				
<5	1.00	1.00	1.00	1.00
6	1.14 (0.83 to 1.55)	1.07 (0.87 to 1.31)	0.88 (0.48 to 1.51)	1.09 (0.83 to 1.44)
7	1.18 (0.88 to 1.59)	1.15 (0.95 to 1.41)	0.96 (0.64 to 1.45)	1.10 (0.83 to 1.46)
8	1.09 (0.82 to 1.45)	1.08 (0.90 to 1.31)	0.78 (0.53 to 1.14)	1.03 (0.79 to 1.33)
9	1.01 (0.66 to 1.54)	1.06 (0.83 to 1.36)	0.85 (0.48 to 1.51)	0.96 (0.67 to 1.38)
≥10	0.76 (0.45 to 1.27)	0.93 (0.70 to 1.23)	0.66 (0.36 to 1.19)	0.61 (0.40 to 0.95)

*Linear-by-linear association trend tests revealed trends with $p<0.0001$.
BMI, body mass index.

Overall, approximately 25% of participants met PA recommendations. Other studies of adult Hispanics living in Texas have found a range of 22–43.1% meeting PA recommendations^{23–25}; however, the *Healthy People 2020* target is 47.9%²⁶ and clearly more work is needed to engage the Mexican-Americans in this cohort in healthy and active pursuits, particularly among women.

Our finding that men were more likely than women to meet PA recommendations agrees with other studies.^{9–11} Nearly half of men born in the USA or Mexico met PA recommendations, as compared to 19%

of Mexico-born women and 23% of US-born women. Men were also more likely to report strenuous PA, and Mexico-born men were the most likely to report high active occupations. Since the participants' self-reported PA included activity done at work, it is possible that men engaged in more activity through labour-intensive jobs, while women, who primarily reported working in the home, engaged in more light activity. Parra-Medina and Messias²⁷ reported that Mexican-origin women are exposed to PA mainly through housework or employment. In our study, US-born women were the least likely

to report a physically active occupation, but Mexico-born women were the least likely to meet PA recommendations. Occupational data from the 2003–2004 National Health and Nutrition Examination Survey (NHANES) revealed that Mexican-American adults were more likely to report active occupations than Caucasians and African-Americans²⁸ and our results indicate that there are likely gender differences contributing to this pattern.

The odds of meeting PA recommendations showed a general decline with increasing age, particularly among men. As Mexican-American men get older and transition out of the workforce, they may need special attention to maintain an active lifestyle.

We found the odds of meeting PA recommendations increased with increasing education, particularly among Mexico-born and US-born women. This effect was more pronounced among Mexico-born participants as all education levels above middle school were associated with greater odds of meeting recommendations, whereas among US-born participants some college or beyond was associated with greater odds of meeting recommendations. Multivariate adjustment attenuated the effect of college education in Mexico-born and US-born men. Possible explanation for these findings is that participants with some college education may have access to more PA resources and information, including the benefits of being active, and more education could result in a higher paying job and better economic security, potentially providing more opportunities or resources to be active.

A higher acculturation score was associated with greater odds of meeting PA recommendations in all groups except US-born men, which supports previous findings.^{6–11} Prior studies found that acculturation had adverse health effects on behavioural risk factors such as smoking and obesity.^{29–30} However, our findings indicate that greater acculturation has some positive benefits in terms of PA, and therefore, those with lower acculturation scores could be targeted for intervention. Programmes to increase PA for low-accultured individuals could incorporate culturally relevant strategies; for example, intervention materials could be developed in Spanish and English. Such programmes might be especially pertinent given the expected growth of the overall Hispanic population in the USA in the coming decades.

Regarding lifestyle factors, current alcohol consumption was associated with greater odds of meeting PA recommendations in all groups except US-born men, and never-drinkers were less likely to meet PA recommendations. Reasons for these results are unclear, but younger Mexican-Americans are more likely to drink alcohol³¹ as well as meet PA recommendations.¹⁰ Alcohol use may also be a proxy for socioeconomic status and is known to be associated with PA in Mexican-American adults.³² Further research is needed to clarify these associations.

For US-born women, getting 10 or more hours of sleep was associated with reduced odds of meeting PA

recommendations. It is possible that time spent sleeping displaces PA; however, no studies have examined this in Mexican-American adults. The distribution of sleep hours in our study is similar to data from a nationally representative sample.³³ Additionally, evidence suggests that getting 7 h of sleep is associated with decreased risk of mortality³⁴ and higher levels of PA,³³ and all participants (except US-born men) who reported sleeping for 7 h per day were more likely to meet PA recommendations (although results were not significant). It is unknown how interventions targeting multiple health behaviours like PA, alcohol use and sleep might influence health outcomes, but in this cohort, these behaviours appear to be connected and interventions could promote PA and adequate amounts of sleep while emphasising responsible alcohol consumption.

A major strength of this study is the focus on a large cohort of urban-dwelling Mexican-American adults with detailed acculturation information. There is a paucity of data examining gender-specific and country of birth-specific factors associated with meeting PA recommendations in Mexican-Americans. Focusing on underserved individuals is critical to eliminating health disparities, especially for this high-risk population.

Limitations include the self-reported data, which is subject to potential recall bias or socially desirable responses. Factors associated with meeting current US PA recommendations might change over time, especially as technology has advanced tremendously in the past decade providing more options for sedentary activity. As changes in the environment and community during the period of data collection were not assessed, it is possible that changes in these settings may have contributed to results. Additionally, the sample was fairly homogeneous, consisting of primarily female, first-generation immigrants who are overweight or obese and have low levels of education. This lack of variation might have influenced our ability to detect associations and limits the generalisability of study findings. Finally, the PA instrument was a standard tool used in the California teacher's Study¹⁸ but has not been validated.

There are few well-established correlates of meeting PA recommendations in Mexican-American adults and current study findings provide a starting point for theoretical underpinnings and future sex-specific and birthplace-specific interventions that aim to increase PA in this population. While factors associated with meeting activity recommendations were similar for men and women, the magnitude of the associations differed. Specifically, education, acculturation and drinking status produced greater odds of meeting recommendations in both Mexico-born and US-born women, while higher BMI produced lower odds in women and age produced lower odds in men. Future work could include qualitative explorations of the sex-specific barriers and motivating factors that may contribute to Mexican-American women's low PA levels, as well as objective examinations of their physical environment and occupational status as

they contribute to activity levels. More studies are needed to examine where and with whom Mexican-American adults are most active, as well as the type of activities they engage in most frequently.

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REFERENCES

1. U.S. Census Bureau. U.S. Census Bureau Projections Show a Slower Growing, Older, More Diverse Nation a Half Century from Now. <https://www.census.gov/newsroom/releases/archives/population/cb12-243.html> (accessed 18 Jun 2014).
2. Flegal KM, Carroll MD, Ogden CL, *et al.* Prevalence and trends in obesity among US adults, 1999–2008. *JAMA* 2010;303:235–41.
3. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2014. <http://www.cdc.gov/diabetes/pubs/statsreport14.htm?loc=americandiabetesassociation> (accessed 9 Jul 2014).
4. Neighbors CJ, Marquez DX, Marcus BH. Leisure-time physical activity disparities among Hispanic subgroups in the United States. *Am J Public Health* 2008;98:1460–4.
5. Zsembik BA, Fennell D. Ethnic variation in health and the determinants of health among Latinos. *Soc Sci Med* 2005;61:53–63.
6. Vermeesch AL, Stommel M. Physical activity and acculturation among U.S. Latinas of childbearing age. *West J Nurs Res* 2014;36:495–511.
7. Chow W, Chrisman M, R Daniel C, *et al.* Cohort profile: the Mexican American Mano A Mano Cohort. *Int J Epidemiol* 2015. [Epub ahead of print 8 Mar 2015].
8. U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans. 2008. <http://www.health.gov/paguidelines/pdf/paguide.pdf> (accessed 23 Jul 2014).
9. Mier N, Ory MG, Zhan D, *et al.* Levels and correlates of exercise in a border Mexican American population. *Am J Health Behav* 2007;31:159–69.
10. Oluyomi AO, Whitehead LW, Burau KD, *et al.* Physical activity guideline in Mexican-Americans: Does the built environment play a role? *J Immigr Minor Health* 2014;16:244–55.
11. Crespo CJ, Smit E, Carter-Pokras O, *et al.* Acculturation and leisure-time physical inactivity in Mexican American adults: Results from NHANES III, 1988–1994. *Am J Public Health* 2001;91:1254–7.
12. Schiller JS, Lucas JW, Ward BW, *et al.* Summary health statistics for U.S. adults: National Health Interview Survey, 2010. *Vital Health Stat* 2012;10:1–207. http://www.cdc.gov/nchs/data/series/sr_10/sr10_252.pdf (accessed 29 Jul 2014).
13. Patterson PD, Moore CG, Probst JC, *et al.* Obesity and physical inactivity in rural America. *J Rural Health* 2004;20:151–9.
14. US Department of Health and Human Services. Classification of overweight and obesity by BMI, waist circumference, and associated disease risks. http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm (accessed 15 Aug 2014).
15. Tudor-Locke C, Washington TL, Ainsworth BE, *et al.* Linking the American Time Use Survey (ATUS) and the compendium of physical activities: methods and rationale. *J Phys Act Health* 2009;6:347–53.
16. Bidimensional Acculturation Scale for Hispanics. Antioch University New England. http://www.antiochne.edu/multiculturalcenter/test/test_titles10/ (accessed 23 Jul 2014).
17. Cuellar I, Arnold B, Maldonado R. Acculturation Rating Scale for Mexican-Americans-II: a revision of the original ARSMA scale. *Hispanic J Beh Sci* 1995;17:275–304.
18. Mai PL, Sullivan-Halley J, Ursin G, *et al.* Physical activity and colon cancer risk among women in the California Teachers Study. *Cancer Epidemiol Biomarkers Prev* 2007;16:517–25.
19. Chau JY, Grunseit AC, Chey T, *et al.* Daily sitting time and all-cause mortality: a meta-analysis. *PLoS ONE* 2013;8:e80000.
20. Centers for Disease Control and Prevention. Prevalence and Trends Data, Texas—2012 Alcohol Consumption. <http://apps.nccd.cdc.gov/brfss/display.asp?cat=AC&yr=2012&qkey=8361&state=TX> (accessed 24 Jun 2014).
21. Centers for Disease Control and Prevention. Prevalence and Trends Data, Texas—2012 Overweight and Obesity (BMI). <http://apps.nccd.cdc.gov/brfss/display.asp?cat=OB&yr=2012&qkey=8261&state=TX> (accessed 24 Jun 2014).
22. Centers for Disease Control and Prevention. State Tobacco Activities Tracking and Evaluation (STATE) System. <http://apps.nccd.cdc.gov/statesystem/HighlightReport/HighlightReport.aspx?FromHomePage=Y&StateName=Texas&StatId=TX> (accessed 24 Jun 2014).
23. Carlson SA, Fulton JE, Schoenborn CA, *et al.* Trend and prevalence estimates based on the 2008 physical activity guidelines for Americans. *Am J Prev Med* 2010;39:305–13.
24. Centers for Disease Control and Prevention. Behavioural Risk Factor Surveillance System (BRFSS) Prevalence and Trends Data: Texas-2011 Physical Activity. <http://apps.nccd.cdc.gov/brfss/race.asp?cat=PA&yr=2011&qkey=8271&state=TX>. (accessed 25 Jul 2014).
25. Dang MM. Evidence of reliability and validity of IPAQ for Mexican-American adults. *Tex Med Cent Diss ProQuest*. 2009:1–31.
26. US Department of Health and Human Services. Healthy People 2020 Summary of Objectives. <http://healthypeople.gov/2020/topics/objectives/2020/pdfs/PhysicalActivity.pdf> (accessed 15 Jul 2014).
27. Parra-Medina D, Messias DKH. Promotion of physical activity among Mexican-origin women in Texas and South Carolina: An examination of social, cultural, economic, and environmental factors. *Quest* 2011;63:100–17.
28. Gay JL, Buchner DM. Ethnic disparities in objectively measured physical activity may be due to occupational activity. *Prev Med* 2014;63:58–62.
29. Antecol H, Bedard K. Unhealthy assimilation: why do immigrants converge to American health status levels? *Demography* 2006;43:337–60.
30. Pérez-Stable EJ, Ramirez A, Villareal R, *et al.* Cigarette smoking behaviour among US Latino men and women from different countries of origin. *Am J Public Health* 2001;91:1424–30.
31. Caetano R, Mills B, Vaeth PAC. Alcohol consumption and binge drinking among U.S.-Mexico border and non-border Mexican Americans. *Alcohol Clin Exp Res* 2012;36:677–85.
32. Ham SA, Yore MM, Kruger J, *et al.* Physical activity patterns among Latinos in the United States: Putting the pieces together. *Prev Chronic Dis* 2007;4. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2099290/> (accessed 15 Sep 2014).
33. Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol* 2009;169:1052–63.
34. Kripke DF, Garfinkel L, Wingard DL, *et al.* Mortality associated with sleep duration and insomnia. *Arch Gen Psychiatry* 2002;59:131–6.