Associations in physical activity and sedentary behaviour among the immigrant and non-immigrant US population

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ABSTRACT

Background Immigrants are at a higher risk of poor mental and physical health. Regular participation in physical activity (PA) and low levels of sedentary time are beneficial for both these aspects of health. The aim was to investigate levels and trends in domain-specific PA and sedentary behaviour in the US immigrant compared with non-immigrant populations.

Methods From the 2007–2016 National Health and Nutrition Examination Survey (NHANES), a total of 25 142 adults (≥ 18 years) were included in this analysis. PA and sedentary behaviour time were assessed by a questionnaire.

Results Transit-related PA showed downward linear trends in young immigrant adults ($p_{\text{trend}}=0.006$) and middle-aged non-immigrant adults ($p_{\text{trend}}=0.009$). We found significant upward linear trends in sedentary behaviour for both immigrants and non-immigrants across all age groups. For sitting watching TV or videos ≥ 2 hours/day, there was a downward linear trend in young immigrant adults ($p_{\text{trend}}=0.009$). For computer use ≥ 1 hours/day, an upward linear trend in older non-immigrants was found ($p_{\text{trend}}=0.024$). Young immigrants spent 37.5 (95% CI –55.4 to –19.6) min less than non-immigrants on recreational PA per week. Also, older immigrants spent 23.5 (95% CI 1.5 to 45.6) and 22.5 (95% CI 5.9 to 39.0) min/week more than non-immigrants on recreational PA and transit-related PA, respectively. Last, young and middle-aged immigrants spent 37.6 (95% CI –68.2 to –7.0) and 37.6 (95% CI –99.7 to –9.7) min/day less than non-immigrants on sedentary behaviour, respectively.

Conclusion Overall, levels of recreational PA were stable, yet the transit-related PA declined coupled with an increase in sedentary behaviour. US immigrants exhibit higher levels of transit-PA, lower levels of leisure-time PA and lower levels of sedentary behaviour, in some age groups.

INTRODUCTION

An immigrant is a person who comes to live permanently in a foreign country. The US has more immigrants than any other country worldwide. Since 1965, when US immigration laws replaced a national quota system, the number of immigrants living in the US more than quadrupled. Immigrants today account for 13.6% of the US population, nearly triple that observed (4.7%) in 1970.¹ Importantly, a large body of literature suggests that immigrants are at a higher risk of poor mental health including schizophrenia and related

disorders,² mood disorders³ and, among women, postpartum depressive symptoms.⁴ Immigration may be detrimental to mental health because it may be associated with a ‘culture shock’ and with greater physical distances from family and friend support networks.^{5–6}

The majority of immigrants tend to have a lower socioeconomic status (SES). This is likely owing to underemployment,⁷ discrimination⁸ and financial and social barriers.⁹ Importantly, lower SES is associated with poorer health, greater morbidity and a higher risk of mortality.^{10–13} In support, it has been shown that in the US, recent immigrants experienced the largest cardiovascular health declines over time: immigrants living in the US < 10 years at baseline experienced a greater decline in the Cardiovascular Health Score (–1.04, 95% CI –1.27 to –0.80) over 10 years compared with those who were US born (–0.47, 95% CI –0.52 to –0.42).¹⁴ Moreover, a lower SES is also associated with lower levels of physical activity (PA).¹⁵

Importantly, the participation (or not) in health behaviours either positively or negatively influences both mental and physical health, such that regular participation in recreational or transportation PA (one health behaviour) is beneficial for almost every facet of mental and physical health.¹⁶ Conversely, high levels of sedentary time are detrimental to most aspects of health.¹⁷ Population levels of PA are generally low^{18–19} and sedentary behaviour high, particularly in the US.²⁰ It is possible that low levels of PA and high levels of sedentary time are partly driving the higher prevalence of poor mental and physical health among immigrant populations. A study conducted on 784 cancer patients found that immigrants were less likely to be aware of and benefited from PA participation.²¹ In a large Canadian study carried out over a decade ago, it was shown that immigrants exhibited relatively low levels of leisure-time PA.²² In another Canadian study, recent and established immigrants were more likely to have an active commute, but a lower likelihood of walking, sports, endurance, and recreation activities than non-immigrants.²³ To our knowledge, no literature exists on levels of PA or sedentary behaviour among the US immigrant population. It is important to understand such levels to inform novel avenues for intervention to improve the mental and physical health of the US immigrant population.

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The aim of the present study was to investigate the trends and patterns of domain-specific PA and sedentary behaviour in the US immigrant compared with non-immigrant populations.

MATERIALS AND METHODS

Study population

Data were extracted from the five cycles of the 2007–2016 National Health and Nutrition Examination Survey (NHANES). Data were released in 2-year cycles (eg, 2007–2008 and 2009–2010). The NHANES is a cross-sectional study that applies a complex, multistage, stratified, clustered probability design to assess the health and nutritional status of the US civilian non-institutionalised population. The NHANES protocol was approved by the review board of the National Center for Health Statistics Ethics. All participants provided written consent to participate in the survey. In the present study, age groups were defined as young (18–35 years), middle-aged (36–55 years) and older adults (>55 years).²⁴ We extracted data on sociodemographic information, and PA and sedentary behaviour and the variables were combined into a single dataset for each data cycle from the 2007–2008 to 2015–2016 cycles.

Immigration status

Immigration status was assessed using the following question: 'In what country were you born?' Response options included 'born in 50 US States or Washington, DC', 'born in Mexico', 'born in other Spanish-speaking country' and 'born in other non-Spanish-speaking country'. If participants were born in 50 US States or Washington, DC, they were classified as non-immigrants. If participants were born in Mexico, other Spanish-speaking country, or other non-Spanish-speaking country, they were classified as immigrants.

Physical activity and sedentary behaviour measures

PA and sedentary behaviour measures were based on the Global Physical Activity Questionnaire (GPAQ) developed by the WHO for PA surveillance.²⁵

Self-reported recreational or transit-related PA included a series of questions. The questions included typical frequency and duration of PA performed during transportation and leisure activities. Weekly recreational PA was assessed using the following questions: (1) 'In a typical week, how many days do you do vigorous-intensity (or moderate-intensity) sport, fitness or recreational activities' and (2) 'How much time do you spend doing vigorous-intensity (or moderate-intensity) sport, fitness or recreational activities on a typical day?' Weekly transit-related PA was assessed using the following questions: (1) 'In a typical week, how many days do you walk or bicycle for at least 10 min continuously to get to and from places' and (2) 'How much time do you spend walking or bicycling for travel on a typical day?' Weekly recreational PA was calculated by adding reported minutes (ie, frequency × duration) of moderate PA to minutes of vigorous PA, then converted to hours for the ease of interpretation. Daily sedentary behaviour, including time spent sitting at a desk, travelling in a car or bus, reading, playing cards, watching television or using a computer, was measured using a single question: 'How much time do you usually spend sitting on a typical day?' Screen-based sedentary behaviours (eg, watching TV or videos, using a computer or play computer) were assessed using following two questions: (1) 'Over the past 30 days, on average, how many hours per day did you sit and watch television or videos?' and (2) 'Over the past 30 days, on

average, about how many hours per day did you use a computer or play computer games outside of school or work', with options of none, less than 1 hour, 1 hour, 2 hours, 4 hours or 5 hours or more per day. For primary analyses, participants' responses were recategorised into ≥2 hours per day and <2 hours per day for sitting watching television and ≥1 hour per day and <1 hour per day for computer use. These cut-offs have been used, as well as approximated median values, in previous studies.^{26 27} Data for sitting watching television and computer use were available only in the 2011–2016 cycle.

Covariate variables

Self-reported sociodemographic characteristics included age, sex (male, female), race/ethnicity (non-Hispanic white, Mexican American, other Hispanic, non-Hispanic black, other race), household income (< \$25 000, \$25 000–\$45 000, >\$45 000–\$75 000, >\$75 000), education level (some high school or less, high school graduate, some college, college graduate or above), work status (currently working or not) and occupational PA as control variables. These covariates were selected because they were hypothesised to be associated with both the exposure and outcome^{7 9 28} and available within the NHANES dataset.

Statistical analysis

All statistical analyses were performed using SURVEY analysis procedures in SAS version 9.4 (SAS institute INC., Cary, North Carolina) to account for the sample weights, stratification and clustering of the complex nature of the NHANES sampling scheme. Participants' descriptive characteristics by immigration status were analysed for each subgroup as mean and frequency using SURVEYMEANS and SURVEYFREQ procedures, respectively. Mean weekly recreational and transit-related PA time and daily sedentary behaviour time were calculated by years. Tests for linear trends were performed to examine trends of each PA time and sedentary behaviour by the cycles using orthogonal polynomial coefficients. Multivariable linear regression was used to examine the association between immigration status and PA and sedentary behaviour using the pooled sample, including all participants of all cycles. We estimated the association of immigration status with recreational PA, transit-related PA and sedentary behaviour. For adjusted models, age, sex, race/ethnicity, income, education level, work status and NHANES year cycles were controlled for. Statistical significance was set a priori at p value < 0.05.

RESULTS

A total of 30 587 men and women aged ≥18 years provided data on PA, sedentary behaviour and immigration status. A total of 5445 participants were excluded due to missing covariates, leaving a total of 25 142 in the final analyses. Overall, 16.8% of the participants were immigrants. Unweighted sample size and weighted percentage in the 2015–2016 cycle are presented in table 1 (data not shown for occupational PA). In this sample, the average age of immigrants and non-immigrants was 44.7 (SE=0.4; 49.0% men) and 47.8 (SE=0.3; 47.4% men), respectively.

Table 2 displays the secular trends in weighted mean hours of recreational PA per week across the NHANES cycles from 2007–2008 to 2015–2016. We did not find a significant trend in immigrant or non-immigrant participants by age group. For transit-related PA (table 3), there were downward linear trends in young immigrant adults ($p_{\text{trend}}=0.006$) and middle-aged non-immigrant adults ($p_{\text{trend}}=0.009$). Table 4 indicates trends in weighted mean hours of sedentary behaviour per day. We found

Table 1 Participant characteristics of the National Health and Nutrition Examination Survey Study in 2015–2016

	Immigrant (n=1572)		Non-immigrant (n=3216)	
Age (years) (SE)	N	%	N	%
18–35	396	31.2	924	28.9
36–55	630	43.5	1014	35.0
>55	546	25.3	1278	36.1
Sex				
Men	753	49.0	1540	47.4
Women	819	51.0	1676	52.6
Race				
Mexican American	433	25.3	374	4.8
Other Hispanic	403	21.4	210	2.7
Non-Hispanic White	76	14.5	1558	76.3
Non-Hispanic Black	133	8.6	877	11.6
Other Race	527	30.3	197	4.5
Household income				
<\$25 000	493	26.7	815	15.3
\$25 000–\$45 000	360	21.9	718	18.2
>\$45 000–\$75 000	306	19.6	725	23.4
>\$75 000	413	31.8	958	43.1
Education				
Some high school or less	603	32.0	491	9.9
High school graduate	242	15.3	806	22.1
Some college	316	22.3	1124	34.5
College graduate or above	411	30.3	795	33.6
Working status				
Yes	960	65.3	1852	64.5
No	612	34.7	1364	35.5

All estimates were weighted to be nationally representative of the US population.

significant upward linear trends in sedentary behaviour for both immigrants and non-immigrants across all age groups.

Table 5 shows trends in screen-based sedentary behaviour (eg, sitting watching TV or videos, computer use). For sitting watching TV or videos ≥ 2 hours per day, there were downward linear

trends in young immigrant adults ($p_{\text{trend}}=0.009$). For computer use ≥ 1 hours per day, an upward linear trend in older non-immigrants was found ($p_{\text{trend}}=0.024$).

Table 6 includes crude and adjusted differences in recreational PA, transit-related PA and sedentary behaviour between immigrants and non-immigrants according to age across all study cycles. In the crude model, young (18–35 years) and middle-aged (36–55 years) immigrants spent 45.8 (95% CI –64.8 to –26.9) and 17.2 (95% CI –33.6 to –0.7) min less than non-immigrants on recreational PA per week, respectively. Middle-aged and older immigrants spent 34.2 (95% CI 12.6 to 55.8) and 30.6 (95% CI 13.2 to 47.9) min/week more than non-immigrants on transit-related PA. Also, in all age groups, immigrants spent less than non-immigrants on sedentary behaviour.

In the adjusted model (ie, controlling for age, sex, race/ethnicity, household income, education level, work status, occupational PA and NHANES year cycles), young immigrants spent 37.5 (95% CI –55.4 to –19.6) min less than non-immigrants on recreational PA per week. Also, older immigrants spent 23.5 (95% CI 1.5 to 45.6) and 22.5 (95% CI 5.9 to 39.0) min/week more than non-immigrants on recreational PA and transit-related PA, respectively. Last, young and middle-aged immigrants spent 37.6 (95% CI –68.2 to –7.0) and 37.6 (95% CI –99.7 to –9.7) min/day less than non-immigrants on sedentary behaviour, respectively.

DISCUSSION

In this large representative sample of the US population, it was found that 16.8% of participants were immigrants. Over a period of 8 years, levels of sedentary behaviour increased in both immigrants and non-immigrants. Based on the multivariable regression analysis, it was found that young immigrants between 18 and 35 years spent less time than non-immigrants in recreational PA. Whereas, immigrants older than 55 years spent greater time on transit-related (ie, active travel) and occupational PA than non-immigrants. Finally, for the first time, the present study found that immigrants' aged between 18 and 55 years spent less time in sedentary behaviour than their non-immigrant counterparts.

Findings from the present study support the limited literature in this area. Similar to this study, others have found lower levels of leisure-time PA in immigrant populations compared with

Table 2 Age-specific trends in weighted mean recreational physical activity (hour/week) in the National Health and Nutrition Examination Survey study from 2007 to 2008 to 2015–2016

		Year					p_{trend} for linear	Difference between first and last cycle
		2007–2008	2009–2010	2011–2012	2013–2014	2015–2016		
18 to 35 years	Overall	3.1 (2.7 to 3.5)	3.1 (2.7 to 3.4)	3.7 (3.0 to 4.4)	3.2 (2.7 to 3.7)	3.5 (3.1 to 3.8)	0.145	0.4 (–0.1 to 0.9)
	Immigrant	2.4 (1.8 to 3.1)	2.6 (2.1 to 3.2)	2.8 (2.0 to 3.7)	2.6 (2.2 to 3.0)	2.9 (2.5 to 3.2)	0.273	0.5 (–0.2 to 1.2)
	Non-immigrant	3.3 (2.8 to 3.7)	3.2 (2.7 to 3.6)	3.9 (3.1 to 4.6)	3.3 (2.8 to 3.9)	3.6 (3.2 to 4.0)	0.211	0.3 (–0.3 to 0.9)
36 to 55 years	Overall	2.3 (1.9 to 2.7)	2.4 (2.2 to 2.7)	2.7 (2.3 to 3.1)	2.5 (2.2 to 2.7)	2.7 (2.2 to 3.1)	0.162	0.4 (–0.2 to 1.0)
	Immigrant	2.1 (1.6 to 2.6)	2.2 (1.6 to 2.7)	2.3 (1.9 to 2.7)	2.6 (2.1 to 3.1)	2.2 (1.8 to 2.6)	0.387	0.1 (–0.5 to 0.7)
	Non-immigrant	2.3 (1.8 to 2.8)	2.5 (2.2 to 2.8)	2.8 (2.3 to 3.2)	2.4 (2.2 to 2.7)	2.8 (2.2 to 3.3)	0.199	0.5 (–0.2 to 1.2)
>55 years	Overall	1.8 (1.5 to 2.0)	1.9 (1.6 to 2.2)	2.0 (1.7 to 2.4)	1.9 (1.5 to 2.3)	2.0 (1.7 to 2.3)	0.273	0.2 (–0.2 to 0.6)
	Immigrant	1.9 (0.9 to 2.9)	2.1 (1.4 to 2.8)	1.8 (1.1 to 2.4)	1.9 (1.3 to 2.5)	2.0 (1.6 to 2.3)	0.952	0.1 (–0.9 to 1.1)
	Non-immigrant	1.7 (1.5 to 2.0)	1.9 (1.6 to 2.2)	2.1 (1.7 to 2.4)	1.9 (1.5 to 2.3)	2.0 (1.6 to 2.4)	0.270	0.3 (–0.2 to 0.8)

All estimates were weighted to be nationally representative of the US population; values in parentheses were CIs.

Table 3 Age-specific trend in weighted mean transit-related physical activity (walk/bicycle, hours/week) in the National Health and Nutrition Examination Survey study from 2007 to 2008 to 2015–2016

		Year					p_{trend} for linear	Difference between first and last cycle
		2007–2008	2009–2010	2011–2012	2013–2014	2015–2016		
18 to 35 years	Overall	1.9 (1.3 to 2.5)	1.5 (1.2 to 1.7)	2.2 (1.4 to 2.9)	1.6 (1.1 to 2.0)	1.2 (1.0 to 1.4)	0.042	–0.7 (–1.3 to –0.1)
	Immigrant	2.1 (1.1 to 3.0)	2.2 (1.5 to 2.9)	2.2 (1.5 to 3.0)	1.3 (0.9 to 1.8)	1.0 (0.7 to 1.3)	0.006	–1.1 (–2.0 to –0.2)
	Non-immigrant	1.8 (1.2 to 2.4)	1.3 (1.1 to 1.5)	2.2 (1.3 to 3.0)	1.6 (1.1 to 2.1)	1.2 (1.0 to 1.4)	0.167	–0.6 (–1.2 to 0.1)
36 to 55 years	Overall	1.4 (1.0 to 1.9)	1.4 (1.1 to 1.8)	1.6 (1.2 to 1.9)	1.0 (0.8 to 1.2)	0.9 (0.6 to 1.2)	0.005	–0.5 (–1.1 to 0.1)
	Immigrant	2.2 (0.9 to 3.5)	2.0 (1.4 to 2.5)	1.9 (1.2 to 2.6)	1.3 (0.6 to 1.9)	1.4 (0.8 to 1.9)	0.104	–0.8 (–2.1 to 0.5)
	Non-immigrant	1.3 (0.9 to 1.7)	1.3 (0.9 to 1.7)	1.5 (1.1 to 1.9)	0.9 (0.7 to 1.2)	0.7 (0.4 to 1.1)	0.009	–0.6 (–1.1 to –0.1)
>55 years	Overall	0.9 (0.6 to 1.1)	0.7 (0.5 to 0.8)	1.3 (0.9 to 1.6)	0.8 (0.6 to 0.9)	0.7 (0.4 to 0.9)	0.488	–0.2 (–0.6 to 0.2)
	Immigrant	1.6 (0.5 to 2.6)	0.8 (0.5 to 1.0)	2.0 (1.1 to 2.9)	1.1 (0.7 to 1.5)	1.2 (0.6 to 1.7)	0.720	–0.4 (–1.5 to 0.7)
	Non-immigrant	0.8 (0.5 to 1.1)	0.6 (0.4 to 0.8)	1.2 (0.8 to 1.5)	0.7 (0.6 to 0.8)	0.6 (0.4 to 0.8)	0.469	–0.2 (–0.6 to 0.2)

All estimates were weighted to be nationally representative of the US population; values in parentheses were CIs.

Table 4 Age-specific trends in weighted mean total sitting time (hours/day) in the National Health and Nutrition Examination Survey study from 2007 to 2008 to 2015–2016

		Year					p_{trend} for linear	Difference between first and last cycle
		2007–2008	2009–2010	2011–2012	2013–2014	2015–2016		
18 to 35 years	Overall	5.4 (5.0 to 5.7)	5.8 (5.5 to 6.0)	6.4 (6.0 to 6.7)	7.1 (6.7 to 7.5)	6.9 (6.4 to 7.5)	<0.001	1.5 (0.8 to 2.2)
	Immigrant	4.6 (4.1 to 5.1)	5.1 (4.4 to 5.7)	5.6 (5.0 to 6.3)	6.6 (5.9 to 7.2)	6.6 (5.2 to 8.1)	0.001	2.0 (0.4 to 3.6)
	Non-immigrant	5.5 (5.2 to 5.9)	5.9 (5.7 to 6.2)	6.5 (6.2 to 6.9)	7.2 (6.7 to 7.7)	7.0 (6.3 to 7.7)	<0.001	1.5 (0.7 to 2.3)
36 to 55 years	Overall	5.6 (5.2 to 5.9)	6.0 (5.6 to 6.3)	6.4 (6.1 to 6.8)	7.4 (6.9 to 8.0)	7.3 (6.6 to 8.0)	<0.001	1.7 (0.9 to 2.5)
	Immigrant	4.3 (3.5 to 5.1)	5.1 (4.1 to 6.1)	5.6 (4.8 to 6.5)	6.3 (5.9 to 6.6)	6.0 (5.1 to 6.9)	0.001	1.7 (0.5 to 2.9)
	Non-immigrant	5.9 (5.6 to 6.2)	6.2 (5.9 to 6.5)	6.6 (6.3 to 6.9)	7.7 (7.1 to 8.3)	7.6 (6.8 to 8.4)	<0.001	1.7 (0.9 to 2.5)
>55 years	Overall	6.5 (5.7 to 7.3)	6.2 (5.8 to 6.7)	7.0 (6.5 to 7.5)	7.8 (7.4 to 8.2)	7.6 (6.8 to 8.4)	0.001	1.1 (–0.1 to 2.2)
	Immigrant	5.3 (4.1 to 6.4)	6.1 (4.3 to 7.9)	5.8 (4.9 to 6.7)	7.0 (6.0 to 8.0)	7.4 (5.4 to 9.3)	0.033	2.1 (–0.4 to 4.6)
	Non-immigrant	6.6 (5.7 to 7.6)	6.3 (5.8 to 6.7)	7.2 (6.6 to 7.7)	7.9 (7.5 to 8.4)	7.7 (6.8 to 8.5)	0.004	1.1 (–0.2 to 2.4)

All estimates were weighted to be nationally representative of the US population; values in parentheses were CIs.

non-immigrants.²³ Several factors may explain the observed association. First, previous literature has suggested that immigrants are less aware of the benefits of regular participation in PA,²¹ and being less knowledgeable of the benefits of PA is a shown risk factor for lower levels of PA.²⁹ Next, immigrants are likely to be from a lower SES,¹³ and a lower SES is associated with lower levels of PA¹⁵ likely owing to a lesser importance placed on this behaviour. In previous literature, immigrants reported higher levels of discrimination,³⁰ and such discrimination may prevent immigrants from participating in leisure-time PA where they may be required to integrate/mix with natives, such as a sport clubs or exercise classes. Finally, we speculate that time constraint may contribute to the lack of opportunities for leisure-time PA among immigrants as well. Although little data are available specifically among immigrant populations, time constraints have shown to negatively impact leisure-time PA such as sports participation.³¹ ‘Too busy’ is a term used among US migrant workers that prevents them to access healthcare.³² Likewise, time constraints may pose even stronger barriers for their leisure-time PA participation.

The present study found higher levels of transit PA among older immigrants. This finding supports that of the only other study to investigate domain-specific PA among immigrants.²¹ It may be that immigrants do not have access to personal automated transport likely owing to cost and SES. Indeed, in the US, ethnic minorities (a proxy for immigrant status) are less likely to own

cars.³³ While the present study found lower levels of leisure-time PA in the younger age (18–35 years) immigrant US population, higher levels of leisure-time PA were found in the older age (>55 years) immigrant population compared with the non-immigrant population, after adjusting for a range of covariates including occupational PA. It is possible that the working-age immigrants may compensate heavy occupational PA with less time spent in leisure-time PA. Indeed, immigrants are more likely to undertake manual occupations than non-immigrants.³⁴

For the first time, the present study has shown that levels of sedentary behaviour in young and middle-aged immigrants are lower than that of non-immigrants. Immigrants tend to perform worse in education than non-immigrants, particularly in subjects such as science.³⁵ Therefore, it may be that natives are spending greater time in homework-type activities that are by nature sedentary. Owing to the fact that immigrants are more likely to be from a lower SES,¹³ it is also possible that they are less likely to have game consoles, tablets and computers and thus have less opportunity to engage in sedentary behaviour. However, these hypotheses remain untested, and future work of a qualitative nature to identify potential mechanisms is now required. Interestingly, observed lower levels of sedentary behaviour among immigrant populations may partly explain the immigrant mortality paradox where immigrants experience greater longevity.^{13 36 37} Indeed, higher levels of sedentary time have been shown to be associated with early all-cause mortality.³⁸

Table 5 Trend in weighted percentage of sitting watching TV or videos ≥ 2 hours per day and computer use outside school or work ≥ 1 hour per day

		Year			p_{trend} for linear	Difference between first and last cycle
		2011–2012	2013–2014	2015–2016		
Sitting watching TV or videos ≥ 2 hours per day, weighted % (95% CI)						
18 to 35 years	Overall	61.8 (55.6 to 68.0)	61.9 (59.4 to 64.5)	57.2 (54.0 to 60.3)	0.193	−4.6 (−11.5 to 2.3)
	Immigrant	63.6 (58.4 to 68.9)	54.3 (48.4 to 60.2)	52.5 (46.3 to 58.8)	0.009	−11.1 (−19.5 to −2.7)
	Non-immigrant	61.3 (54.1 to 68.5)	63.4 (60.8 to 66.0)	58.2 (55.0 to 61.5)	0.438	−3.1 (−11.1 to 4.9)
36 to 55 years	Overall	62.2 (58.6 to 65.9)	63.9 (60.4 to 67.3)	61.9 (56.9 to 66.9)	0.913	−0.3 (−6.4 to 5.8)
	Immigrant	52.1 (46.2 to 53.8)	51.8 (45.1 to 58.5)	46.3 (42.0 to 50.6)	0.117	−5.8 (−11.7 to 0.1)
	Non-immigrant	64.8 (60.9 to 68.8)	67.0 (63.3 to 70.6)	66.0 (59.6 to 72.5)	0.752	1.2 (−6.1 to 8.5)
>55 years	Overall	79.7 (76.7 to 82.7)	81.1 (78.1 to 84.2)	83.5 (80.4 to 86.7)	0.083	3.8 (−0.6 to 8.2)
	Immigrant	67.9 (61.9 to 73.9)	65.9 (59.9 to 71.8)	69.2 (62.7 to 75.8)	0.767	1.3 (−7.9 to 10.5)
	Non-immigrant	81.2 (77.9 to 84.5)	83.4 (80.1 to 86.7)	85.7 (82.3 to 89.1)	0.066	4.5 (−0.3 to 9.3)
Computer use outside school or work ≥ 1 hour per day, weighted % (95% CI)						
18 to 35 years	Overall	63.9 (59.0 to 68.7)	55.3 (52.2 to 58.4)	56.6 (51.2 to 62.0)	0.049	−7.3 (−14.6 to −0.1)
	Immigrant	58.9 (48.1 to 69.8)	53.8 (47.5 to 60.1)	47.2 (38.9 to 55.5)	0.089	−11.7 (−25.2 to 1.8)
	Non-immigrant	65.0 (60.2 to 69.8)	55.6 (52.0 to 59.2)	58.7 (53.0 to 64.4)	0.096	−6.3 (−13.7 to 1.1)
36 to 55 years	Overall	46.7 (43.4 to 49.9)	47.5 (43.8 to 56.2)	48.8 (46.2 to 51.5)	0.308	2.1 (−2.1 to 6.3)
	Immigrant	43.1 (38.0 to 48.3)	38.4 (33.6 to 43.2)	40.8 (36.2 to 45.5)	0.504	−2.3 (−9.3 to 4.7)
	Non-immigrant	47.6 (43.5 to 51.7)	49.9 (45.8 to 54.0)	51.0 (48.0 to 53.9)	0.181	3.4 (−1.9 to 8.7)
>55 years	Overall	40.3 (35.4 to 45.2)	44.2 (40.0 to 48.5)	48.1 (43.7 to 52.5)	0.021	7.8 (1.1 to 14.5)
	Immigrant	27.9 (20.7 to 35.1)	33.9 (27.5 to 40.2)	34.9 (27.3 to 42.6)	0.183	7.0 (−3.8 to 17.8)
	Non-immigrant	41.9 (36.6 to 47.1)	45.8 (41.5 to 50.0)	50.1 (45.3 to 54.9)	0.024	8.2 (0.9 to 15.5)

All estimates were weighted to be nationally representative of the US population; values in parentheses were CIs.

It should be noted that the present study found mixed findings on generation differences, for example, only finding higher levels of transit PA in older immigrants. Reasons behind this generational difference are not currently clear, and further research to tease out explanations for these nuances are now required.

Clear strengths of the present study include the large representative sample of the US adult population and the investigation of domain-specific PA levels and sedentary behaviour by immigration status in the US population for the first time. However, the findings from the study should be interpreted in light of its limitations. First, PA was self-reported, thus introducing reporting bias, but such self-report tools allow for the measuring of domain-specific PA on a population scale. Second, the data are of cross-sectional nature, and thus it is not known whether leisure-time PA levels of immigrants were low before they entered the

US. Finally, no data were available on age at immigration or whether participants have immigrants as parents this would have allowed for a more nuanced analysis.

CONCLUSION

In conclusion, the present study found that US immigrants exhibit higher levels of transit PA, lower levels of leisure-time PA and lower levels of sedentary behaviour, in some but not all age groups. These findings should be considered when designing interventions to improve the health and well-being of the US immigrant population. Future work is needed to shed light on the underlying mechanisms driving the observed associations. In addition, future studies should investigate the role of immigrant status in the association of PA and sedentary behaviour with health-related outcomes.

Table 6 Beta coefficients of the association of immigrant status with recreational and transit-related physical activity (PA) and sedentary behaviour from the linear regression models

		18 to 35 years		36 to 55 years		>55 years	
		Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Recreational PA	Non-immigrant	Reference		Reference		Reference	
	Immigrant	–45.8* (–64.8 to –26.9)	–37.5* (–55.4 to –19.6)	–17.2* (–33.6 to –0.7)	10.1 (–11.2 to 31.5)	–0.1 (–18.1 to 17.9)	23.5* (1.5 to 45.6)
Transit-related PA	Non-immigrant	Reference		Reference		Reference	
	Immigrant	8.8 (–12.2 to 29.9)	6.0 (–13.6 to 25.6)	34.2* (12.6 to 55.8)	13.6 (–14.8 to 41.9)	30.6* (13.2 to 47.9)	22.5* (5.9 to 39.0)
Sedentary behaviour	Non-immigrant	Reference		Reference		Reference	
	Immigrant	–46.1* (–72.3 to –20.0)	–37.6* (–68.2 to –7.0)	–78.7* (–101.7 to –55.8)	–54.7* (–99.7 to –9.7)	–45.8* (–86.6 to –4.9)	–27.5 (–79.6 to 24.7)

adjusted: beta coefficient when controlling for age, gender, race/ethnicity, education level, income, occupational physical activity and NHANES year cycles; PA, physical activity; unadjusted, crude beta coefficient; units are minutes per week for physical activity and per day for sedentary behaviour; values in parentheses were CIs; * <0.05 .

What is already known on this subject

- ▶ A large body of literature suggests that immigrants are at a higher risk of poor mental health and poor cardiovascular health.
- ▶ The participation (or not) in health behaviours either positively or negatively influences both mental and physical health.
- ▶ No literature exists on levels of physical activity or sedentary behaviour among the US immigrant population.

What this study adds

- ▶ Levels of sedentary behaviour increased regardless of immigration status.
- ▶ US immigrants exhibit higher levels of transit-related physical activity, lower levels of leisure-time physical activity and lower levels of sedentary behaviour, in some but not all age groups.
- ▶ These findings should be considered when designing interventions to improve the health and well-being of the US immigrant population.

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