**Associations in physical activity and sedentary behavior 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 behavior in the U.S. immigrant compared to 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 behavior time were assessed by a questionnaire.

**Results:** Transit-related PA showed downward linear trends in young immigrant adults (*p*trend=.006) and middle-aged non-immigrant adults (*p*trend=.009). We found significant upward linear trends in sedentary behavior 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 (ptrend=.009). For computer use ≥1 hours/day, an upward linear trend in older non-immigrants was found (ptrend=.024). Young immigrants spent 37.5 (95% CI: -55.4 to -19.6) minutes less than non-immigrants on recreational physical activity per week. Also, older immigrants spend 23.5 (95% CI: 1.5 to 45.6) and 22.5 (95% CI: 5.9 to 39.0) minutes per week more than non-immigrants on recreational physical activity and transit-related physical activity, respectively. Lastly, 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) minutes per day less than non-immigrants on sedentary behavior, respectively.

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

**Key words:** Immigration; Physical Activity; Sedentary; NHANES.

**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 behaviors either positively or negatively influences both mental and physical health.
* No literature exists on levels of physical activity or sedentary behavior among the U.S. immigrant population.

**What this study adds?**

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

**INTRODUCTION**

An immigrant is a person who comes to live permanently in a foreign country. The U.S. has more immigrants than any other country worldwide. Since 1965, when U.S. immigration laws replaced a national quota system, the number of immigrants living in the U.S. more than quadrupled. Immigrants today account for 13.6% of the U.S. 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 disorders[3] 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 under-employment,[7] discrimination,[8] and financial and social barriers [9] etc. 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 U.S., recent immigrants experienced the largest cardiovascular health declines over time: immigrants living in the U.S. < 10 years at baseline experienced a great decline in the cardiovascular health score (−1.04, 95% CI: −1.27 to −0.80) over 10-year compared with those who were U.S. born (−0.47, 95% CI: −0.52 to −0.42).[14] Moreover, a lower SES is also associated with lower levels of physical activity.[15]

Importantly, the participation (or not) in health behaviors either positively or negatively influences both mental and physical health. Such that regular participation in recreational or transportation physical activity (one health behavior) is beneficial for almost every facet of mental and physical health. [16] Conversely, high levels of sedentary time is detrimental to most aspects of health. [17] Population levels of physical activity are generally low [18,19] and sedentary behavior high, particularly in the U.S.[20] It is possible that low levels of physical activity 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 physical activity 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 physical activity.[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 physical activity or sedentary behavior among the U.S. immigrant population. It is important to understand such levels to inform novel avenues for intervention to improve the mental and physical health of the U.S. immigrant population.

The aim of the present study was to investigate trends and patterns of domain-specific physical activity and sedentary behavior in the U.S. immigrant compared to 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 was released in two-year cycles (e.g., 2007-2008, 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 U.S. civilian non-institutionalized 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 extract data on sociodemographic information, and physical activity and sedentary behavior and the variables were combined in to a single dataset for each data cycle form the 2007-2008 to 2015-2016 cycles.

**Immigration status**

Immigration status was assessed using following a 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 Behavior Measures**

Physical activity and sedentary behavior measures were based on the Global Physical Activity Questionnaire (GPAQ) developed by the World Health Organization (WHO) for physical activity surveillance.[25]

Self-reported recreational or transit-related physical activity included a series of questions. The questions included typical frequency and duration of physical activity performed during transportation and leisure activities. Weekly recreational physical activity 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 physical activity was assessed using the following questions: (1) “In a typical week, how many days do you walk or bicycle for at least 10 minutes 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 physical activity was calculated by adding reported minutes (i.e., frequency × duration) of moderate physical activity to minutes of vigorous physical activity, then converted to hours for the ease of interpretation. Daily sedentary behavior, 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 behaviors (e.g., watching TV or videos, using a computer or play computer) were assess 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 re-categorized 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), occupational physical activity as control variables. These covariates were selected because they were hypothesized 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 analyses for each subgroups as mean and frequency using SURVEYMEANS and SURVEYFREQ procedures, respectively. Mean weekly recreational and transit-related physical activity time, and daily sedentary behavior time were calculated by years. Tests for linear trends were performed to examine trends of each physical activity time and sedentary behavior by the cycles using orthogonal polynomial coefficients. Multivariable linear regression was used to examine association between immigration status, and physical activity and sedentary behavior using the pooled sample including all participants of all cycles. We estimated the association of immigration status with recreational physical activity, transit-related physical activity, and sedentary behavior. 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 < .05.

**RESULTS**

A total of 30,587 men and women aged ≥18 years provided data on physical activity, sedentary behavior and immigration status. A total of 5,445 participants were excluded due to missing covariates, leaving a total of 25,142 in the final analyses. Overall, 16.8% of participants were immigrants. Unweighted sample size and weighted percentage in the 2015-2016 cycle are presented in Table 1 (occupational physical activity data not shown). In this sample, average age of immigrants and non-immigrants were 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 physical activity 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 physical activity (Table 3), there were downward linear trends in young immigrant adults (*p*trend = .006) and middle-aged non-immigrant adults (*p*trend = .009). Table 4 indicated trends in weighted mean hours of sedentary behavior per day. We found significant upward linear trends in sedentary behavior for both immigrants and non-immigrants across all age groups.

Table 5 showed trends in screen-based sedentary behavior (e.g., sitting watching TV or videos, computer use). For sitting watching TV or videos ≥ 2 hours per day, there was downward linear trends in young immigrant adults (*p*trend = .009). For computer use ≥ 1 hours per day, an upward linear trend in older non-immigrants was found (*p*trend = .024).

Table 6 included crude and adjusted differences in recreational physical activity, transit-related physical activity, and sedentary behavior 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) minutes less than non-immigrants on recreational physical activity 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) minutes per week more than non-immigrants on transit-related physical activity. Also, in all age groups, immigrants spent less than non-immigrants on sedentary behavior.

In the adjusted model (i.e. controlling for age, sex, race/ethnicity, household income, education level, work status, occupational physical activity, and NHANES year cycles), young immigrants spent 37.5 (95% CI: -55.4 to -19.6) minutes less than non-immigrants on recreational physical activity per week. Also, older immigrants spend 23.5 (95% CI: 1.5 to 45.6) and 22.5 (95% CI: 5.9 to 39.0) minutes per week more than non-immigrants on recreational physical activity and transit-related physical activity, respectively. Lastly, 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) minutes per day less than non-immigrants on sedentary behavior, respectively.

**DISCUSSION**

In this large representative sample of the U.S. population it was found that 16.8% of participants were immigrants. Over a period of eight years, levels of sedentary behavior increased in both immigrants and non-immigrants. Based on the multivariable regression analysis, it was found that young immigrants between 18-35 years spent less time than non-immigrants in recreational physical activity. Whereas, immigrants older than 55 years spent greater time on transit-related (i.e., active travel) and occupational physical activity than non-immigrants. Finally, for the first time, the present study found that immigrants’ aged between 18-55 years spent less time in sedentary behavior 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 physical activity in immigrant populations compared to 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 physical activity,[21] and being less knowledgeable of the benefits of physical activity is a shown risk factor for lower levels of physical activity.[29] Next, immigrants are likely to be from a lower SES[13] and a lower SES is associated with lower levels of physical activity[15] likely owing to a lesser importance placed on this behavior. In previous literature, immigrants reported higher levels of discrimination,[30] and such discrimination may prevent immigrants from participating in leisure time physical activity 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 physical activity among immigrants as well. Although little data is available specifically among immigrant populations, time constraints have shown to negatively impact leisure-time physical activity such as sports participation.[31] “Too busy” is a term used among U.S. migrant workers that prevents them to access health care.[32] Likewise, time constraints may pose even stronger barriers for their leisure-time physical activity participation.

The present study found higher levels of transit physical activity among older immigrants. This finding supports that of the only other study to investigate domain-specific physical activity among immigrants.[21] It may be that immigrants do not have access to personal automated transport likely owing to cost and socio-economic status. Indeed, in the U.S., ethnic minorities (a proxy for immigrant status) are less likely to own cars.[33] While the present study found lower levels of leisure-time physical activity in the younger age (18-35 years) immigrant U.S. population, higher levels of leisure-time physical activity 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 physical activity. It is possible that the working age immigrants may compensate heavy occupational physical activity with less time spent in leisure time physical activity. Indeed, immigrants are more like to undertake manual occupations than non-immigrants.

For the first time, the present study has shown that levels of sedentary behavior 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.[34] 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, computers and thus have less opportunity to engage in sedentary behavior. 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 behavior among immigrant populations may partly explain the immigrant mortality paradox were immigrants experience greater longevity. [13,35,36] Indeed, higher levels of sedentary time has been shown to be associated with early all cause-mortality.[37]

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

Clear strengths of the present study include the large representative sample of the U.S. adult population and the investigation of domain-specific physical activity levels and sedentary behavior by immigration status in the U.S. population for the first time. However, the findings from the study should be interpreted in light of its limitations. First, physical activity was self-reported thus introducing reporting bias, but such self-report tools allow for the measuring of domain-specific physical activity on a population scale. Second, the data is of cross-sectional nature and thus it is not known whether leisure time physical activity 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 U.S. immigrants exhibit higher levels of transit- physical activity, lower levels of leisure-time physical activity, and lower levels of sedentary behavior, in some but not all age groups. These findings should be considered when designing interventions to improve the health and wellbeing of the U.S. 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 physical activity and sedentary behavior with health-related outcomes.

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| Table 1. Participant characteristics of the National Health and Nutrition Examination Survey study in 2015-2016. |
|  | Immigrant(n = 1,572) |  | Non-immigrant(n = 3,216) |  |
| Age (years) yrs (s.e.) | 44.7 (0.4a) |  | 47.8 (0.3a) |  |
|  | N | % | N | % |
|  18-35 | 396 | 31.2 | 924 | 28.9 |
|  36-55 | 630 | 43.5 | 1,014 | 35.0 |
|  >55 | 546 | 25.3 | 1,278 | 36.1 |
| Sex |  |  |  |  |
|  Men | 753 | 49.0 | 1,540 | 47.4 |
|  Women | 819 | 51.0 | 1,676 | 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 | 1,558 | 76.3 |
|  Non-Hispanic Black | 133 | 8.6 | 877 | 11.6 |
|  Other Race | 527 | 30.3 | 197 | 4.5 |
| Household income |  |  |  |  |
|  < $25000 | 493 | 26.7 | 815 | 15.3 |
|  $25000 - $45000 | 360 | 21.9 | 718 | 18.2 |
|  >$45000 - $75000 | 306 | 19.6 | 725 | 23.4 |
|  > $75000 | 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 | 1,124 | 34.5 |
|  College graduate or above | 411 | 30.3 | 795 | 33.6 |
| Working status |  |  |  |  |
|  Yes | 960 | 65.3 | 1,852 | 64.5 |
|  No | 612 | 34.7 | 1,364 | 35.5 |
| Note. All estimates were weighted to be nationally representative of the US population; astandard error. |

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| Table 2.  Age-specific trends in weighted mean recreational physical activity (hour/week) in the National Health and Nutrition Examination Survey study from 2007-2008 to 2015-2016   |
|  |  | Year |  |  |
|   |   | 2007-2008 | 2009-2010 | 2011-2012 | 2013-2014 | 2015-2016 | *p* Trendfor linear | Difference between first and last cycle |
| 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) |
| Note. All estimates were weighted to be nationally representative of the US population; values in parentheses were confidence intervals.  |

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| 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 2007-2008 to 2015-2016 |
|  |  | Year | *p* Trendfor 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) |
| Note. All estimates were weighted to be nationally representative of the US population; values in parentheses were confidence intervals. |

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| Table 4.  Age-specific trends in weighted mean total sitting time (hours/day) in the National Health and Nutrition Examination Survey study from 2007-2008 to 2015-2016  |
|  |  | Year | *p* Trendfor 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) | <.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) | <.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) | <.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) | <.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) |
| Note. All estimates were weighted to be nationally representative of the US population; values in parentheses were confidence intervals. |

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| Table 5.  Trend in weighted percentage of sitting watching TV or videos ≥ 2 hour per day and computer use outside school or work ≥ 1 hour per day.  |
|  |  | Year | *p* Trendfor 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) |
| Note. All estimates were weighted to be nationally representative of the US population; values in parentheses were confidence intervals. |

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| Table 6. Beta coefficients of the association of immigrant status with recreational and transit-related physical activity (PA) and sedentary behavior from the linear regression models. |
|  |  | 18-35 years | 36-55 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 behavior | 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) |
| Note. PA=physical activity; Unadjusted: crude beta coefficient; Adjusted: Beta coefficient when controlling for age, gender, race/ethnicity, education level, income, occupational physical activity, and NHANES year cycles; units are minutes per week for physical activity and per day for sedentary behavior; values in parentheses were confidence intervals; \* <.05 |