

REVIEW

Obesity Management / Intervention

Trends in adherence to physical activity guidelines from 1997 to 2018 among adults with obesity: An analysis from the US National Health Interview Survey

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Summary

The aim of this study was to estimate the temporal trends in adherence rates to the physical activity (PA) guidelines for aerobic and muscle-strengthening activities (MSA) among United States (US) adults with obesity. We retrieved data from 22 consecutive rounds of the National Health Interview Survey (NHIS) conducted between 1997 and 2018. Meeting with the PA guidelines recommended by the World Health Organization was determined as follows: individuals achieving ≥ 150 weekly minutes of moderate physical activity (MPA), ≥ 75 weekly minutes of vigorous physical activity (VPA), and ≥ 2 weekly MSA training sessions. The prevalence of meeting PA guidelines increased from 9.4% in 1997 to 15.0% in 2018, although less than 2 in 10 adults with obesity met the guidelines throughout the study period. Overall, compared to females, males with obesity were more likely to adhere to PA recommendations (odds ratio (OR) = 2.03 [95% confidence interval (CI), 1.94 to 2.12]). Also, each age year significantly reduced the odds of adhering to PA recommendations overall (OR = 0.97 [95% CI, 0.97 to 0.98]). Compared with their White counterparts, Black and other races people with obesity have higher significant odds of adhering to PA recommendations with, respectively, OR = 1.18 (95% CI, 1.12 to 1.24) and OR = 1.30 (95% CI, 1.18 to 1.43). In representative samples of adults with obesity from the US, there was an increasing trend for meeting PA guidelines, although only less than 2 in 10 met them.

KEYWORDS

physical inactivity, sedentary behavior, health disparities, overweight

1 | INTRODUCTION

The epidemic of overweight and obesity presents a major challenge to chronic disease prevention and health across the life course around the world.¹ Worldwide obesity has nearly tripled since 1975.² In 2016, over 650 million adults (18 years and older) had obesity.²

Excess weight (obesity and overweight) is one of the key risk factors for many noncommunicable diseases (NCD) such as coronary heart disease, hypertension, stroke, certain types of cancer, type 2 diabetes, gallbladder disease, dyslipidemia, osteoarthritis and gout, and pulmonary diseases.³ Furthermore, the economic impact of obesity (and overweight) in 2019 was estimated at 2.19% of the global gross

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domestic product; being 1110\$ per capita in high-income countries (e.g., United States (US)).⁴

On the other hand, the World Health Organization (WHO) recognizes a major risk factor for the development and progression of chronic illnesses as being physical inactivity.⁵ For this reason, global health experts prioritize increasing physical activity (PA) levels.⁶ In adults, PA provides benefits for a myriad of health outcomes: all-cause and cardiovascular disease mortality, mental health (anxiety and depression), cognitive health and sleep, and incidence of hypertension, type 2 diabetes, and site-specific cancers.⁵ In this sense, for adults (aged 18–64 years), including those living with disabilities and chronic diseases, the WHO establishes the following guidelines⁵: a) engage in regular PA; b) do at least 150–300 min of moderate-intensity aerobic PA, or at least 75–150 min of vigorous-intensity aerobic PA, or an equivalent combination of both intensities throughout the week for substantial health benefits; c) do muscle-strengthening activities (MSA) at moderate or greater intensity that involve all major muscle groups on two or more days a week, as these provide additional health benefits.

Although, the etiology of obesity is complex⁷ and involves the interaction of social, biological, genetic, and environmental factors (among others),⁸ PA has been identified as an important lifestyle behavior that can impact body weight and body composition, and it can therefore influence both the prevention and treatment of overweight and obesity.⁹ However, a recent systematic review and meta-analysis by García-Hermoso et al¹⁰ indicated that, in large samples of individuals from 32 countries, only 19% of adolescents and 17% of adults met both the guidelines for aerobic and MSA. Segmenting by nutritional status, these same authors observed that only 9% of people with obesity met with both guidelines. More specifically, in the US, a previous study by Zhao et al¹¹ a prevalence of 17.3% was reported; however, the aim of these authors was not to determine the specific prevalence in this population, and they did not examine this prevalence segmented by certain factors that could be associated with meeting PA guidelines (e.g., sex, age, race/ethnicity).

A previous study by Whitfield et al¹² identified that the prevalence of inactivity decreased from 40.5% (1998) to 25.6% (2018) while the prevalence of meeting the high aerobic guideline increased from 26.0% to 37.4%. Furthermore, these same authors indicated that the increases in insufficient activity and meeting the minimal guideline were statistically significant but of relatively small magnitude.¹² However, these findings were not stratified by weight status, which makes it impossible to know whether these prevalences are identical in the population at higher risk for chronic non-communicable diseases (e.g., obesity). Understanding the current status and secular changes in adherence to the PA guidelines over time in this specific population and its potential sociodemographic moderators (e.g., sex, age, race/ethnicity) is critical to inform future research and public health policy.¹³ This fact is especially relevant in the population living with obesity, given their risk of developing numerous non-communicable diseases. In this study, we used nationally representative data from the National Health Interview Survey (NHIS) from 1997 to 2018 to estimate the temporal trends in adherence rates to the PA guidelines for aerobic and MSA among US adults with obesity.

2 | METHODS

2.1 | Study design and sample

We retrieved data from 22 consecutive rounds of the NHIS conducted between 1997 and 2018. The NHIS is a nationally representative survey of the noninstitutionalized population living in the US. The Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics conducts this survey annually and receives ethical approval.¹⁴ Briefly, trained interviewers conducted personal interviews in households selected from random clusters through a stratified, complex multi-stage sampling approach. Thereupon, a sample of adults was randomly selected from these households to answer a health-related survey.¹⁴

From an initial sample of 671,696 participants, we discarded those with missing data on body mass index (BMI) ($n = 26,140$), not eligible because $BMI < 30 \text{ kg/m}^2$ (i.e., WHO threshold for obesity) ($n = 475,614$), or missing values in moderate physical activity (MPA), vigorous physical activity (VPA) or MSA ($n = 10,271$) which left a final sample size of 159,671 adults with obesity (≥ 18 years) for the present study. The reporting of this study followed the guidelines of the Observational Routinely collected Health Data Statement.¹⁵

2.2 | Adherence to the PA guidelines

Information on PA was measured through the following questions:

1. Frequency of light intensity PA or MPA: "How often do you do light or moderate leisure-time physical activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate?" (20 minutes for participants of the 1997 NHIS);
2. Duration of MPA: "About how long do you do these light or moderate leisure-time physical activities each time?";
3. Frequency of VPA: "How often do you do vigorous leisure time physical activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate?" (20 minutes for participants of the 1997 NHIS);
4. Duration of VPA: "About how long do you do these vigorous leisure time physical activities each time?"

We estimated the total amount of MPA and VPA (weekly minutes) by multiplying frequency and duration.

On the other, hand, adherence to the MSA guidelines was assessed through the following question: "How often do you do physical activities specifically designed to strengthen your muscles, such as lifting weights or doing calisthenics?"

According to the current recommended WHO guidelines concerning MPA, VPA, and MSA, individuals achieving either ≥ 150 weekly minutes of MPA or ≥ 75 weekly minutes of VPA, and ≥ 2 weekly MSA training sessions were considered to meet current WHO guidelines for PA.

2.3 | Covariates

According to prior research,¹⁶ participants were categorized into different age groups: 18–24 years, 25–34 years, 35–44 years, 45–64 years, and ≥ 65 years in the main analyses. We also considered self-reported demographic and lifestyle related-variables such as age as

continuous variable (years), sex (male/female), race/ethnicity (white/black/other), education (lower than high school degree/high school degree/higher than high school degree), smoking status (never/former/current smoker), body mass index (body weight in kilograms divided by height in meters squared), number of chronic conditions, functional limitations defined as having any degree of difficulty while performing a specific physical task (i.e., walking a quarter of a mile, walking up ten steps, standing for two hours, sitting for two hours, carrying a ten pound object, overhead arm reach, stooping, bending, kneeling, pushing a large object or grasping an object), or engaging in social activities and recreation (i.e., relaxing, going shopping, attending club meetings, visiting friends, sewing, reading, visiting a doctor's office or going to parties) without the assistance of another person or using special equipment (no/yes), and survey year (1997 to 2018).

2.4 | Statistical analysis

Statistical analyses of individual data were conducted between November 2022 and January 2023 using Stata software version 16.1. Survey analysis procedures accounted for sample weights and the

complex sampling design of NHIS. The crude weighted prevalence and 95% confidence intervals (CIs) of PA guidelines were estimated for the survey year and age group. The overall crude linear trends in current PA guidelines were examined using linear regression models across survey years, which also served to estimate the regression coefficients and 95% CIs for the year change. *P*-values for trends were calculated using the survey year as a continuous variable, whereas absolute differences in the estimated prevalence of PA guidelines were estimated by comparing the 2018 survey with the 1997 baseline survey. Moreover, crude trends in PA guidelines were visually illustrated. Logistic regressions were used to model the prevalence of PA guidelines and to estimate the odds ratios (ORs). Individuals with missing data in any of the examined covariates were excluded from the regression analyses ($n = 3326$) (2.1%). Statistical significance was set at $p < 0.05$.

3 | RESULTS

A total of 159,671 participants (mean age 48.4 years [standard deviation (SD) = 16.2], 56% females) were included in the study. The

TABLE 1 Sample size for aerobic and muscle strengthening physical activity recommendations in the US population with obesity by sociodemographic, lifestyle, and physical condition characteristics, National Health Interview Survey 2018^a.

	Overall	No. of participants by age subgroup (weighted %)				
		18–24 y	25–34 y	35–44 y	45–64 y	≥65 y
No.	7297	373	1056	1215	2751	1902
Weighted N	72,281,669	6,071,960	12,622,538	12,886,987	26,996,571	13,703,613
Sex						
Female	3358(49.1)	194(51.7)	600(53.0)	651(48.3)	1431(50.7)	1063(51.7)
Male	3939(50.9)	179(48.3)	456(47.1)	564(51.7)	1320(49.3)	839(48.3)
Race/ethnicity						
White	5812(79.0)	281(77.5)	808(76.0)	911(74.1)	2237(80.5)	1575(83.8)
Black	1140(15.8)	65(16.7)	181(17.5)	226(18.6)	410(15.3)	258(12.0)
Other	345(5.3)	27(5.9)	67(6.5)	78(7.2)	104(4.2)	69(4.2)
Education						
<High school	902(12.7)	56(15.0)	96(8.9)	139(12.4)	308(12.2)	303(16.4)
High school	239(3.3)	10(19.5)	27(2.8)	47(4.5)	94(3.4)	61(3.3)
>High school	6156(84.0)	307(83.0)	933(8.8)	1029(83.1)	2349(84.4)	1538(80.3)
Smoking						
Never smoker	4252(61.2)	297(82.2)	686(65.6)	711(59.0)	1596(60.5)	962(51.4)
Former smoker	1979(24.7)	30(8.8)	163(15.1)	251(21.7)	730(25.4)	805(42.0)
Current smoker	1059(14.0)	45(8.8)	205(19.2)	253(19.3)	423(1.1)	133(6.5)
Missing	7(0.1)	1(0.2)	2(0.1)	0(0.0)	2(0.1)	2(0.1)
Chronic conditions, mean (SD)	1.4(2.1)	0.5(0.9)	0.5(1.6)	0.8(1.2)	1.4(1.5)	2.5(3.0)
BMI (kg/m²), mean (SD)	35.5(5.4)	35.4(5.3)	36.1(5.7)	35.8(5.5)	35.7(5.7)	34.8(4.7)
Functional limitation						
No	3363(51.1)	287(79.4)	777(73.6)	784(64.6)	1137(43.4)	378(20.1)
Yes	3933(48.9)	85(20.4)	279(26.5)	431(35.4)	1614(56.6)	1524(80.0)
Missing	1(0.0)	1(0.2)	0(0.0)	0(0.0)	0(0.0)	0(0.0)

^aParticipant characteristics were presented overall and by age group. BMI, body mass index.

TABLE 2 Crude-weighted trends among the US population with obesity across survey years, National Health Interview Survey 1997–2018.^{a,b} Prevalence of adherence to current recommendations for aerobic and muscle strengthening physical activity in the US (150 minutes of moderate physical activity or 75 minutes of vigorous physical activity, and two or more strength training sessions per week), weighted % (95% CI).

Age, y	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Overall	9.4(8.6–10.2)	8.6(7.7–9.5)	9.3(8.4–10.2)	9.6(8.6–10.6)	10.3(9.4–11.1)	11.6(10.6–12.5)	9.9(9.0–10.8)	10.4(9.5–11.3)	10.8(9.9–11.7)	11.8(10.7–12.8)	11.3(10.2–12.4)	12.8(11.6–14.0)	11.7(10.7–12.7)
18–24	18.0(14.1–22.0)	17.0(12.4–21.6)	17.2(12.4–22.0)	17.6(13.5–21.7)	18.7(14.3–23.0)	17.2(13.2–21.3)	20.3(15.3–25.3)	15.2(11.3–19.1)	17.8(13.7–22.0)	17.2(12.6–21.8)	19.0(14.2–23.7)	18.8(13.7–23.8)	15.8(12.0–19.7)
25–34	12.7(10.7–14.7)	13.5(11.2–15.8)	13.5(11.2–15.8)	14.1(11.6–16.6)	15.1(12.8–17.3)	17.1(14.4–19.9)	14.1(11.9–16.2)	13.5(11.1–15.8)	14.1(11.8–16.3)	18.9(15.3–22.5)	16.4(13.7–19.1)	18.9(15.6–22.2)	15.6(12.7–18.4)
35–44	10.3(8.6–12.1)	11.1(9.1–13.2)	11.1(9.1–13.2)	10.5(8.6–12.3)	12.4(10.4–14.3)	14.3(12.1–16.4)	10.3(8.4–12.2)	10.3(8.5–12.2)	12.5(10.4–14.5)	13.6(11.3–16.0)	12.3(9.8–14.8)	13.7(11.0–16.3)	14.6(12.2–16.9)
45–64	6.6(5.4–7.8)	6.4(5.1–7.7)	6.4(5.1–7.7)	7.1(5.9–8.4)	7.2(6.0–8.4)	8.8(7.4–10.1)	7.6(6.3–8.8)	9.5(8.2–10.8)	8.2(7.1–9.3)	9.3(7.8–10.9)	8.9(7.4–10.4)	10.3(8.8–12.2)	9.7(11.3–12.2)
≥65	4.7(3.2–6.2)	3.6(2.2–5.0)	3.6(2.2–5.0)	3.9(2.6–5.1)	3.9(2.6–5.1)	4.5(3.1–6.0)	4.3(2.9–5.8)	6.1(4.6–7.7)	7.1(5.4–8.7)	4.2(2.6–5.7)	5.5(3.6–7.5)	7.5(5.2–9.8)	6.1(4.5–7.8)
Age, y	2010	2011	2012	2013	2014	2015	2016	2017	2018	B (95% CI)^c	p for trend^d	2018 vs. 1997 survey, Difference (95% CI)	
Overall	13.8(12.7–14.9)	14.9(13.9–15.9)	13.3(12.4–14.3)	13.1(12.2–14.1)	14.0(13.0–15.1)	14.9(13.8–15.9)	14.5(13.4–15.6)	15.6(14.5–17.0)	15.0(13.9–16.1)	0.3(0.3–0.4)	p < 0.001	5.6(4.2–7.0)	
18–24	22.5(17.8–27.3)	24.5(19.9–29.2)	19.9(15.4–24.3)	18.9(13.9–23.8)	21.5(17.1–26.0)	25.4(19.8–30.9)	22.5(4.3–11.8)	22.9(17.9–27.8)	22.7(17.8–27.6)	0.3(0.2–0.5)	p < 0.001	4.7(–1.6–10.9)	
25–34	19.3(16.8–21.8)	19.3(16.4–22.2)	18.1(5.6–8.8)	19.8(17.1–22.4)	21.1(18.4–23.8)	20.9(18.2–23.7)	21.3(18.2–24.4)	21.6(18.7–24.5)	21.8(18.8–24.7)	0.4(0.3–0.5)	p < 0.001	9.0(5.5–12.6)	
35–44	15.8(13.5–18.1)	17.1(14.9–19.2)	15.8(13.5–18.2)	12.9(11.1–14.6)	16.7(14.5–19.0)	18.0(15.6–20.4)	18.0(15.3–20.6)	20.7(17.9–23.5)	18.7(16.0–21.5)	0.5(0.4–0.5)	p < 0.001	8.4(5.2–11.7)	
45–64	11.5(10.0–13.0)	12.0(10.7–13.2)	10.9(9.5–12.2)	11.4(10.0–12.8)	10.4(8.9–11.9)	12.1(10.5–13.6)	11.0(9.6–12.5)	13.0(11.4–14.5)	11.4(10.0–12.8)	0.3(0.2–0.3)	p < 0.001	4.8(2.9–6.7)	
≥65	6.1(4.8–7.5)	9.4(7.6–11.3)	8.0(6.1–9.8)	7.9(6.4–9.4)	8.9(7.2–10.6)	7.6(6.1–9.2)	8.3(6.8–9.8)	7.5(6.1–9.0)	9.2(7.5–10.8)	0.3(0.2–0.3)	p < 0.001	4.4(2.2–6.6)	

^aSample sizes for individual cells ranges from 338 to 3918 in the age subgroups.

^bAll estimates accounts for the weights and complex survey design of the National Health Interview Survey to be nationally representative.

^cThe estimate unstandardized beta coefficient (B), 95% confidence interval (CI), and p-values for the trend are calculated using linear regression that includes the year of each National Health Interview Survey as a continuous variable. The estimate B can be interpreted as the average annual percentage point change of prevalence.

sample size per survey ranged from 5423 to 10,084. Table 1 shows the weighted sample sizes from the 2018 survey by age subgroup and related covariates.

Table 2 displays the crude weighted trends and adherence levels to PA guidelines across the years for each age subgroup. The overall prevalence of adherence to PA guidelines in the population with obesity significantly increased ($p < 0.001$) from 1997 to 2018 (5.6 [95% CI, 4.2 to 7.0]). The prevalence of adherence to PA guidelines also significantly increased ($p < 0.001$) for all age subgroups from 1997 to 2018 with the exception of the 18–24 years subgroup, which showed a non-significant increase of 4.7 (95% CI, –1.6 to 10.9). The rest of the subgroups comprising 25–34 years, 9.0 (95% CI, 5.5 to 12.6); 35–44 years, 8.4 (95% CI, 5.2 to 11.7); 45–64 years, 4.8 (95% CI, 2.9 to 6.7); and 65 years or older, 4.4 (95% CI, 2.6 to 6.6) showed significant increases of adherence to PA recommendations.

Across all survey years, younger adults with obesity (i.e., subgroups of participants aged 18–24, and 25–34) showed higher adherence levels to PA guidelines than their older counterparts in most of the survey years.

Figure 1 shows the overall crude weighted trends in adherence to PA guidelines throughout the survey years, with a general trend toward increasing adherence and substantial decreases in the years 2003 and 2012.

Table 3 shows weighted ORs of adherence to current PA guidelines in adults with obesity. Overall, compared to females, males with obesity were more likely to adhere to PA recommendations (OR = 2.03 [95% CI, 1.94 to 2.12]). Also, each age year significantly reduced the odds of adhering to PA recommendations overall (OR = 0.97 [95% CI, 0.97 to 0.98]). Compared with their White counterparts, Black and other races people with obesity have higher significant odds of adhering to PA recommendations with respectively OR = 1.18 (95% CI, 1.12 to 1.24) and OR = 1.30 (95% CI, 1.18 to 1.43). Higher level of education (i.e., >high school) showed the highest significant odds for PA recommendations adherence overall

(OR = 2.90 [95% CI, 2.69 to 3.12]), whereas current smoking habits showed the highest significant odds reduction compared to non-smokers (OR = 0.67 [95% CI, 0.63 to 0.71]). Having functional limitations, higher BMI or a higher number of chronic conditions showed overall significant reduced odds to meet PA guidelines with respectively OR = 0.46 (95% CI, 0.44 to 0.48), OR = 0.95 (95% CI, 0.95 to 0.96, and OR = 0.78 (95% CI, 0.7 to 0.79). Finally, survey years showed a significant trend toward higher significant odds of adhering to PA recommendations ($p < 0.001$).

4 | DISCUSSION

Overall, our results showed a significant increase in the PA prevalence of most of the age ranges examined (except for the 18–24 age group). However, less than 2 in 10 adults with obesity met the guidelines throughout the study period. It is important to acknowledge that the prevalence values reported in our study may appear lower when compared to those from Whitfield et al.¹² This discrepancy likely arises from differences in the populations studied and the criteria used to define adherence to PA guidelines. Our study specifically focused on individuals with obesity—a population generally characterized by lower levels of PA—which likely contributes to the lower prevalence observed in our findings. Additionally, the methodology used to assess PA and the thresholds for meeting guidelines may differ from those employed by the CDC. To provide a comprehensive understanding, we have compared our results with the CDC data in this discussion and emphasized the specific context of our target population. More specifically, this finding agrees with a previous systematic review and meta-analysis by García-Hermoso et al.¹⁰ that found a lower prevalence in participants with obesity (9.8%) in comparison with the BMI status of others (i.e., underweight, normal weight, and overweight). Attention should be paid to the pertinent motives and barriers regarding PA that have been acknowledged and necessitate targeting.

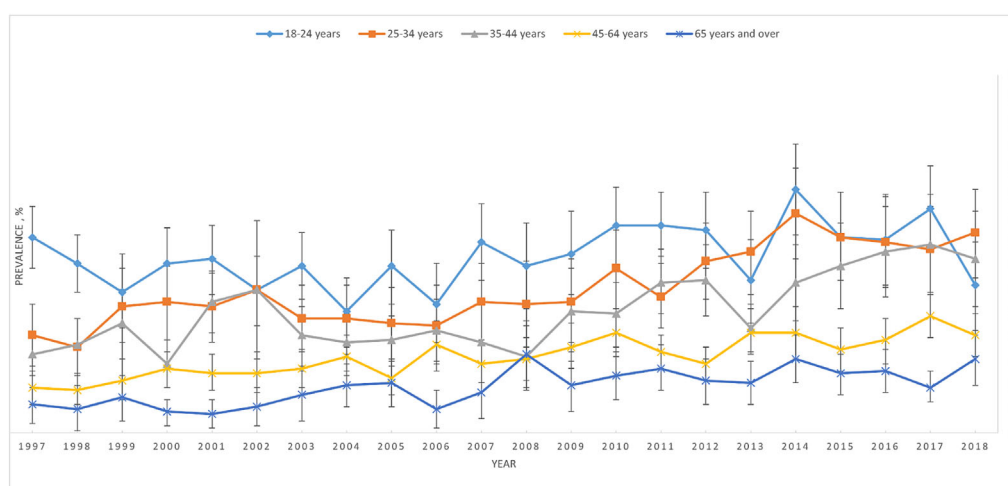


FIGURE 1 Crude weighted trends in current recommendations for aerobic and muscle strengthening activity among US adults, 1997–2018, by age subgroup (prevalence and 95% confidence intervals (CIs))^{a, b}. All estimates accounted for the weights and complex survey design of the National Health Interview Survey to be nationally representative. Error bars indicate 95% CIs.

TABLE 3 Weighted logistic regression models of adherence to current recommendations for aerobic and muscle strengthening activity in the United States (150 minutes of moderate physical activity or 75 minutes of vigorous physical activity, and two or more strength training sessions per week), adjusted for sociodemographic, lifestyle, and physical conditions characteristics, National Health Interview Survey 1997–2018^a.

Age subgroup	Overall	Odds ratio (95%CI) ^b				
		18–24 y	25–34 y	35–44 y	45–64 y	≥65 y
No.	156,355	10,122	26,816	31,499	59,130	28,788
Age^c	0.97(0.97–0.98)	0.97(0.91–1.00)	0.99(0.98–1.01)	0.97(0.96–0.98)	0.98(0.97–0.98)	0.94(0.93–0.95)
Sex						
Female	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
Male	2.03(1.94–2.12)	2.86(2.49–3.27)	2.13(1.96–2.31)	1.97(1.81–2.14)	1.79(1.67–1.92)	1.72(1.53–1.94)
Race/ethnicity						
White	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
Black	1.18(1.12–1.24)	0.96(0.83–1.13)	1.29(1.17–1.43)	1.20(1.09–1.32)	0.99(0.91–1.09)	0.80(0.67–0.96)
Other	1.30(1.18–1.43)	0.87(0.66–1.14)	1.43(1.20–1.70)	1.41(1.15–1.73)	0.90(0.75–1.08)	1.20(0.84–1.71)
Education						
<High school	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
High school	1.37(1.24–1.52)	0.79(0.60–1.05)	1.27(1.04–1.55)	1.64(1.32–2.04)	1.63(1.35–1.97)	1.19(0.90–1.60)
>High school	2.90(2.69–3.12)	1.55(1.28–1.88)	2.56(2.21–2.98)	3.27(2.77–3.88)	3.75(3.26–4.31)	3.70(3.10–4.41)
Smoking						
Never smoker	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
Former smoker	0.83(0.79–0.87)	0.94(0.74–1.19)	1.00(0.89–1.12)	1.02(0.91–1.14)	1.00(0.92–1.09)	1.18(1.04–1.33)
Current smoker	0.67(0.63–0.71)	0.67(0.56–0.79)	0.73(0.65–0.81)	0.64(0.58–0.72)	0.51(0.46–0.57)	0.55(0.41–0.73)
Functional limitation						
No	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
Yes	0.46(0.44–0.48)	0.69(0.58–0.81)	0.63(0.56–0.70)	0.55(0.46–0.64)	0.52(0.48–0.55)	0.46(0.41–0.53)
BMI (kg/m²)^c	0.95(0.95–0.96)	0.96(0.94–0.97)	0.95(0.94–0.96)	0.95(0.94–0.96)	0.94(0.93–0.95)	0.95(0.93–0.96)
Number of chronic conditions^c	0.78(0.76–0.79)	1.03(0.94–1.15)	0.96(0.91–1.01)	0.86(0.82–0.90)	0.84(0.82–0.87)	0.89(0.86–0.93)
Survey						
1997	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)	1(reference)
1998	0.97(0.78–1.06)	0.91(0.61–1.36)	1.05(0.81–1.36)	0.82(0.61–1.10)	0.87(0.65–1.17)	0.84(0.48–1.49)
1999	1.00(0.86–1.16)	0.92(0.59–1.42)	1.04(0.79–1.39)	1.12(0.83–1.51)	0.98(0.72–1.32)	0.79(0.45–1.37)
2000	1.02(0.87–1.18)	0.96(0.65–1.43)	1.11(0.85–1.46)	1.05(0.78–1.39)	1.05(0.79–1.38)	0.88(0.55–1.42)
2001	1.10(0.96–1.26)	1.01(0.69–1.47)	1.12(0.86–1.44)	1.25(0.96–1.62)	1.12(0.85–1.47)	0.85(0.51–1.41)
2002	1.29(1.12–1.47)	0.97(0.65–1.43)	1.42(1.09–1.85)	1.49(1.14–1.96)	1.35(1.03–1.77)	1.00(0.60–1.67)
2003	1.06(0.92–1.23)	1.12(0.73–1.73)	1.10(0.86–1.41)	1.02(0.76–1.36)	1.14(0.87–1.50)	1.05(0.63–1.74)
2004	1.14(0.99–1.30)	0.78(0.52–1.17)	1.09(0.82–1.45)	1.02(0.77–1.36)	1.51(1.19–1.92)	1.48(0.95–2.30)
2005	1.17(1.02–1.35)	0.95(0.63–1.44)	1.12(0.86–1.46)	1.25(0.94–1.67)	1.25(0.98–1.59)	1.63(1.03–2.56)
2006	1.29(1.11–1.49)	0.92(0.60–1.39)	1.58(1.15–2.16)	1.41(1.05–1.88)	1.43(1.08–1.88)	0.92(0.54–1.58)
2007	1.26(1.09–1.45)	1.06(0.69–1.61)	1.33(1.01–1.76)	1.27(0.95–1.70)	1.39(1.06–1.82)	1.37(0.81–2.30)
2008	1.40(1.22–1.61)	1.05(0.68–1.61)	1.52(1.14–2.02)	1.40(1.04–1.88)	1.60(1.23–2.08)	1.75(1.04–2.93)
2009	1.27(1.11–1.46)	0.79(0.53–1.19)	1.25(0.93–1.68)	1.50(1.13–1.99)	1.49(1.15–1.92)	1.45(0.90–2.34)
2010	1.54(1.34–1.78)	1.27(0.86–1.86)	1.61(1.25–2.07)	1.63(1.25–2.11)	1.85(1.44–2.37)	1.41(0.93–2.14)
2011	1.68(1.49–1.90)	1.43(1.00–2.05)	1.65(1.27–2.13)	1.80(1.40–2.31)	1.86(1.47–2.36)	2.24(1.47–3.43)
2012	1.47(1.30–1.68)	1.11(0.75–1.63)	1.42(1.10–1.82)	1.64(1.25–2.16)	1.70(1.34–2.16)	2.02(1.29–3.16)
2013	1.47(1.29–1.67)	1.01(0.66–1.54)	1.71(1.33–2.20)	1.34(1.04–1.72)	1.80(1.40–2.31)	1.87(1.25–2.80)
2014	1.56(1.37–1.78)	1.16(0.81–1.65)	1.82(1.41–2.35)	1.76(1.38–2.25)	1.62(1.25–2.10)	2.13(1.40–3.22)
2015	1.67(1.46–1.90)	1.52(1.02–2.28)	1.78(1.38–2.30)	1.92(1.47–2.53)	1.89(1.48–2.43)	1.77(1.17–2.67)
2016	1.62(1.42–1.86)	1.21(0.80–1.82)	1.85(1.42–2.40)	1.93(1.47–2.53)	1.73(1.35–2.23)	1.99(1.32–3.02)
2017	1.77(1.56–2.01)	1.26(0.85–1.86)	1.84(1.42–2.37)	2.26(1.74–2.94)	2.07(1.62–2.64)	1.82(1.21–2.74)

TABLE 3 (Continued)

Age subgroup	Overall	Odds ratio (95%CI) ^b				
		18–24 y	25–34 y	35–44 y	45–64 y	≥65 y
2018	1.69(1.48–1.94)	1.31(0.89–1.94)	1.88(1.46–2.42)	2.05(1.56–2.68)	1.74(1.36–2.24)	2.22(1.47–3.36)
P for trend ^d	<0.001	0.1	<0.001	<0.001	<0.001	<0.001

^aAll estimates accounted for the weights and complex survey design of the National Health Interview Survey to be nationally representative. Participants with missing values ($n = 3326$) (2.1%) were removed from the analyses.

^bFor categorical variables, the odds ratios (ORs) and 95% confidence intervals (CIs) represent the change in odds expected in each category in relation to the reference group.

^cThe ORs in this row represent the change in odds expected from a 1-unit increase.

^dP for trend over survey was calculated using the National Health Interview Survey years as a continuous variable.

BMI, body mass index.

Specifically, these include deficiencies in motivation, as well as obstacles related to pain and weight management.^{17–19} With respect to the latter, from an ecological perspective, increases in meeting PA guidelines do not appear to translate into a reduction in obesity prevalence in the US, which is consistent with the literature.²⁰ Thus, other complementary strategies to curb the obesity epidemic and its burden (e.g., reducing caloric intake) are likely to be necessary. Notably, obesity is too often misunderstood and characterized as a lifestyle disorder that can be solved if people “eat less and move more”, a message that undermines the complexity of the disease⁷ and overestimates the impact of PA.²¹

Regarding age, we found that for each additional year of the participant, the probability of meeting the PA guidelines was lower. This fact was also observed when segmenting the sample by age group in all established groups. This trend has been consistently reported in the general population (without specific distinction for obesity).¹⁰ The reduction in PA levels as individuals age is a well-established observation in PA epidemiology.²² Age-related changes in physical function and capacity can limit an individual's ability to engage in PA, possibly due to reduced aerobic capacity, muscle function, and efficiency.²³ This fact may be more pronounced in individuals with obesity, as they may have greater difficulty engaging in PA due to the increased joint load caused by excess body weight.²⁴ Our findings confirm that this phenomenon is also present among adults with obesity, highlighting the importance of addressing this issue in this specific population.

In relation to sex, males were more likely to meet PA guidelines in comparison with females, which is in agreement with prior research.^{10,11} The targeting of females in PA promotion strategies is further warranted. Overall, previous research indicates that females tend to do less leisure-time activity, and lower-intensity activity than do males,²⁵ and the present study observed this phenomenon also among the population with obesity. Offering more opportunities for safe and accessible leisure-time PA to females to increase their overall levels of activity would therefore help close the gender gap.²⁶ Furthermore, cultural norms, traditional roles, or lack of social and community support might lead to reduced participation in PA among the female sex.²⁵ Supporting this notion, a recent systematic review has identified barriers and facilitators were grouped into different levels of the socio-ecological model, with the most frequently cited factors being time, body image and societal beauty standards, family duty and social support, religious and cultural norms, organization and community facilities

and environment, safety issues, and physical environment.²⁷ Addressing these barriers and understanding these facilitators is needed to plan and deliver culturally sensitive actions to support behavior change.²⁵

Regarding race/ethnicity, in general, our results indicated that Black people and people with other races (both with obesity) had higher odds of meeting with the PA guidelines compared to White people with obesity. However, when stratifying by age, we did not observe a clear trend with very disparate values depending on race/ethnicity. This result is not in line with the scientific literature which has traditionally suggested that Black people and people from other races are less active than White people. However, the fact that the present results are based on a specific population with obesity might partially explain this issue. Compared with non-Hispanic whites, some barriers to PA participation are reported more often among black and Hispanic adults.²⁸ Although differences in PA across race/ethnicity are well documented, little is known about the nature of these disparities.²⁹ Previous research has examined factors that may explain racial disparities in PA prevalence.^{29,30} People from diverse race/ethnicity tend to live in very different environments, and racial disparities in PA prevalence likely result in part from differences in health risk exposures and/or healthcare resources related to poverty and place.³¹ However, a study by Wilson-Frederick et al³² found that race/ethnicity differences in physical inactivity were not observed within a sample of Blacks and Whites living in similar social contexts. In addition, according to CDC maps, there are differences in the prevalence of physical inactivity in the US by race/ethnicity and location, with non-Hispanic Asian adults having the lowest prevalence of physical inactivity outside of work followed by non-Hispanic White, non-Hispanic American Indian/Alaska Native, non-Hispanic Black, and Hispanic adults.³³ Although we considered the complex survey design and its representativeness, we did not consider the geographic location of the participants, this fact could have influenced the results obtained. Furthermore, the higher proportion of White people with obesity in comparison with Black people or people with other races could (at least partially) justify this disagreement with the literature in relation to the general population. Given this mismatch observed, further studies are necessary to fully understand the facilitators and barriers to exercise across race/ethnicity in people with obesity to guide PA promotion in this specific population and reduce health disparities. Other differences concerning healthy lifestyles such as smoking or

BMI, and issues such as physical function problems or a higher number of chronic conditions have been widely observed in the literature and support the fact that healthier lifestyles (i.e., non-smoking, or healthy BMI) are usually associated with adherence to higher levels of PA.^{34,35} Also, similar to prior research, more physical difficulties and higher number or chronic diseases have been associated with lower levels of PA.³⁶

The present study has some limitations that must be declared. First, as this is a cross-sectional study, we cannot establish cause-effect relationships for the results observed. Second, NHIS assesses self-reported PA, which is subject to social desirability and recall biases. Third, the NHIS asks adults about their PA, specifically focusing on activities that last for 10 minutes or more. The 2008 Physical Activity Guidelines for Americans also required that aerobic PA should occur in bouts of at least 10 minutes. However, the second edition of these guidelines, released in 2018, removed this requirement.³⁷ Current research suggests that removing the 10-minute bout minimum may not have a significant impact on estimates of PA levels.³⁸ Another limitation of our study is the lack of a comparison group comprising individuals of normal weight and overweight. Including these groups could provide a more comprehensive understanding of the trends in PA across different BMI categories. Future research should consider these groups to offer a more complete picture. Conversely, the main strength of this study is the large representative sample size of people with obesity from the US, which allowed for the examination of sex, age, and race/ethnicity groups. Another strength is the increase in scientific knowledge regarding PA in people with obesity, a population that has been less studied.

5 | CONCLUSION

In representative samples of adults with obesity from the US, only less than 2 in 10 met the guidelines for aerobic and MSA. While there has been a substantial improvement in compliance over time, the prevalence of meeting these guidelines remains worryingly low. This underscores the urgency of implementing comprehensive PA activity interventions on a large scale, with sustained political support and effective communication across several sectors.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest statement.

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