HHS Public Access

Author manuscript

Am J Prev Med. Author manuscript; available in PMC 2025 June 01.

Published in final edited form as:

Am J Prev Med. 2024 June ; 66(6): 1008–1016. doi:10.1016/j.amepre.2024.01.023.

Physical Activity According to Diabetes and Metropolitan Status: United States 2020 and 2022

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Abstract

Introduction: Physical activity (PA) can reduce morbidity and mortality among adults with diabetes. While rural disparities in PA exist among the general population, it is not known how these disparities manifest among adults with diabetes.

Methods: Data from the 2020 and 2022 National Health Interview Survey were analyzed in 2023 to assess prevalence of meeting aerobic and muscle-strengthening recommendations according to the 2018 Physical Activity Guidelines for Americans during leisure time. PA prevalence was computed by diabetes status, type of PA, and urban/rural residence (large central metro, large fringe metro, medium/small metro, and non-metro). Logistic regression models were used to estimate prevalence and prevalence ratios of meeting PA recommendations by urban/rural residence across diabetes status.

Results: Among adults with diabetes in non-metro counties, only 23.8% met aerobic, 10.9% met muscle-strengthening, and 6.2% met both PA recommendations. By contrast, among adults with diabetes in large fringe metro counties, 32.1% met aerobic, 19.7% met strengthening, and 12.0% met both guidelines. Multivariable adjusted prevalence of meeting muscle-strengthening recommendations was higher among participants with diabetes in large fringe metro compared to large central metro counties (PR=1.27; 95% CI 1.03-1.56). Among those without diabetes, adjusted prevalence of meeting each recommendation or both was lower in non-metro and small/medium metro compared to large central metro counties.

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Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conclusions: Adults with diabetes are less likely to meet the PA recommendations than those without, and differences exist according to urban/rural status. Improving PA among rural residents with diabetes may mitigate disparities in diabetes-related mortality.

Introduction

Adults with type 2 diabetes have been shown to have a reduced life expectancy compared with adults without diabetes, particularly due to higher risk of fatal cardiovascular events.[1, 2] Physical activity (PA) may reduce cardiovascular mortality and risk factors for complications among persons with diabetes, such as poor glycemic control, hypertension, overweight and obesity, and dyslipidemia.[3, 4] The 2018 *Physical Activity Guidelines for Americans* (referred to as 'guidelines' hereafter) recommend that persons with chronic health conditions such as diabetes engage in aerobic and strength training PA, trying to meet recommendations if they are able [5] with potential exceptions and modifications as needed.[6] However, despite the potential health benefits of PA, adults with diabetes are less likely to be physically active than those without diabetes.[7, 8] In 2015 only 31% of adults with diabetes in the United States (US) met aerobic PA recommendations, 13% met strength training, and 9% met both aerobic and strength training recommendations.[9]

Rural (non-metropolitan) communities in the US experience higher prevalence of diabetes[10, 11] and of diabetes related mortality than metropolitan communities.[12] Rural communities in general also lag in meeting PA guidance with only 38% of adults in nonmetro counties meeting aerobic guidelines compared to 50% in large central and fringe metro counties.[13] However, it is not known how this manifests among adults with diabetes. Therefore, the aim of this study is to assess prevalence of meeting PA guidelines during leisure time among adults with and without diabetes according to urban/rural county of residence.

Methods

Study Population

The study sample included 56,851 participants 18 years and older from the 2020 and 2022 National Health Interview Survey (NHIS) with self-reported information on diabetes diagnosis and PA. NHIS is an annual cross-sectional household survey of the civilian non-institutionalized population of the US which collects data from study participants primarily through face-to-face interviews throughout the year. Households are sampled using a geographically clustered sampling method; a sample adult is randomly selected from each selected household for collection of self-reported health data.[14, 15] Due to the COVID-19 pandemic, many interviews conducted in 2020 and 2022 were performed by telephone rather than face-to-face, with 70.7% and 55.7% of sample adult interviews at least partially conducted by telephone in 2020 and 2022, respectively. In 2020, the NHIS sample included 31,568 adults, of whom 21,153 were interviewed as part of the 2020 annual sample and 10,415 were re-interviewed adults from the 2019 sample. The response rate for the 2020 new sample was 48.9% and 29.6% for the re-interview sample. For the present study, both the 2020 annual sample and the re-interviewed adults from the 2019 sample were included; 1,185 participants were excluded because they had missing information on self-reported diabetes or PA status, leaving a final 2020 sample of 30,383. In 2022, the sample included

27,651 adults and had a response rate of 47.7%; 1,183 participants were excluded because they had missing data on self-reported diabetes or PA status, leaving a final 2022 sample of 26,468. The study was exempt from IRB review because it used deidentified publicly available data.

Measures

Diabetes status was classified based on self-reported diagnosis by a physician or other healthcare professional. Using the county or county-equivalent of residence of each participant, metropolitan status served as a proxy for urban/rural status and was classified into four categories: large central metropolitan (metro), large fringe metro, medium and small metro, and non-metro, using the 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties.[16]

Participants reporting ≥150 minutes of moderate leisure-time activity, ≥75 minutes of vigorous activity, or equivalent combination of moderate and vigorous activity per week were categorized as meeting aerobic PA recommendations as per the Guidelines. Participants who reported performing muscle-strengthening exercises such as weight-training, push-ups, or sit-ups two or more times per week during leisure time were classified as meeting muscle-strengthening PA recommendations. Specific survey questions assessing PA can be found in the appendix.

Other variables included age (18-44, 45-64, 65-74, 75+ years), sex, race/ethnicity (Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, non-Hispanic Other), education level (<high school, high school diploma/GED, some college/associate degree, bachelor's degree or higher), and family income to poverty ratio (continuous). Family income to poverty ratio was from the sample adult datasets and is based on the ratio of annual family income to the poverty threshold for family size. Missing values for the derived family income to poverty variable were replaced with a single imputation provided by the National Center for Health Statistics.

Statistical Analysis

Data analysis was performed in 2023. Demographic characteristics, residential and geographic distributions of the population, and prevalence of meeting guidance on aerobic PA, muscle-strengthening PA, or both were compared by diabetes status using two-tailed t-tests for continuous variables and chi-squared tests for categorical variables. Predicted margins from logistic regression models were used to estimate age-adjusted prevalence and multivariable adjusted prevalence ratios (PR) and 95% confidence intervals (CI) of meeting aerobic PA, muscle-strengthening PA, or both recommendations by urban/rural classification (with large central metro as the reference group) across diabetes status. Separate age adjusted and multivariable adjusted models were fit for each of the three outcomes for a total of six models. Multivariable models included variables which have been previously associated with both physical activity level and diabetes: age, sex, race/ethnicity, income to poverty ratio, and education. Prevalence ratios were considered significant when the 95% CI did not contain the null value of 1.0. All statistical analyses accounted for the survey design variables (strata, primary sampling unit) and sampling weights of NHIS and were

conducted using SAS-callable SUDAAN v11.0 with significance levels set at $p < 0.05$. To assess the appropriateness of pooling data from 2020 and 2022, supplemental analysis was also performed using chi-squared tests to compare prevalence of meeting guidelines by survey year according to diabetes status and metropolitan status.

Results

Characteristics of the study population by self-report of physician-diagnosed diabetes are shown in Table 1. Compared with adults without diabetes, those with diabetes were older, more likely to be male, less likely to be non-Hispanic white, and had lower education levels and incomes. Those reporting diabetes were also more likely to live in non-metro areas, and less likely to report recommended levels of aerobic PA (28.8% vs 49.0%; $p<0.001$), muscle-strengthening PA (15.3% vs. 32.4%; $p<0.001$), or both (9.4% vs. 25.8%; $p<0.001$). In supplemental analysis (data not shown), prevalence of meeting aerobic, strength, or both guidelines did not differ significantly between 2020 and 2022 among those with diabetes or those without diabetes or among adults of any county metropolitan status.

Age-adjusted prevalence of meeting PA guidelines according to diabetes and metro status is shown in Figure 1. Regardless of diabetes status, age-adjusted prevalence of meeting aerobic, muscle-strengthening, or both PA recommendations differed significantly according to metropolitan status ($p<0.001$). Among adults with diabetes in non-metro counties, the proportion reporting PA meeting recommended levels were 23.8% for aerobic PA, 10.9% for muscle-strengthening PA, and 6.2% for both activities. By contrast, 42.6% of adults without diabetes in non-metro counties were found to meet the recommended levels for aerobic PA, 23.8% for muscle-strengthening PA, and 18.5% for both activities.

Age-adjusted prevalence ratios comparing the prevalence of meeting physical activity guidelines among adults with and without self-reported diabetes according to metropolitan status are shown in Figure 2. By metropolitan status, age-adjusted prevalence of adults with diabetes meeting aerobic PA recommendations was 20% lower in non-metro counties than in large central metro counties (PR=0.80; 95% CI: 0.68-0.94). The prevalence of adults with diabetes meeting muscle-strengthening recommended PA levels was 31% higher in large fringe metro than in large central metro counties (PR=1.31; 95% CI 1.08-1.60). The prevalence of meeting both guidelines among adults with diabetes was 39% lower among those in non-metro compared to large central metro counties (PR=0.61; 95% CI: 0.43-0.86). Among adults without diabetes, age-adjusted prevalence of meeting aerobic, muscle-strengthening, or both PA recommendations was lower in small/medium metro and non-metro counties compared to large central metro counties.

Multivariable-adjusted prevalence ratios comparing the prevalence of meeting physical activity guidelines among adults with and without self-reported diabetes according to metropolitan status are shown in Figure 3. After additional adjustment for demographic and socioeconomic characteristics, among those with diabetes, only the prevalence of meeting guidance on muscle-strengthening remained significantly higher in large fringe metro compared to large central metro counties (PR=1.27; 95% CI 1.03-1.56). Among those without diabetes, multivariable adjusted prevalence of meeting each recommendation and

both remained significantly lower in non-metro and small/medium metro counties compared to large central metro counties.

Discussion

The results of this study suggest that adults with diabetes are far less likely to meet the current recommendations from the *Physical Activity Guidelines for Americans* than those without diabetes. Specifically, more than 7 out of 10 adults with diabetes in the US do not meet aerobic PA guidelines, 8 out of 10 do not meet muscle-strengthening guidelines, and 9 out of 10 do not meet the combined PA guidelines. Further, disparities in meeting guidelines were observed among both those with and without diabetes according to metropolitan status, with residents of non-metro and small/medium metro counties generally less likely to meet guidelines compared to large metro counties.

It has been previously demonstrated that adults with diabetes are less likely than those without to engage in PA.[7, 17, 18] Although there is some evidence that the prevalence of meeting PA recommendations has somewhat increased over the last two decades,[17] the results of the present study suggest a disparity by diabetes status persists. However, changes to the NHIS study design in 2019 do not allow direct comparison of 2020 and 2022 prevalence estimates presented here to NHIS estimates published previously. The *Physical Activity Guidelines for Americans* generally apply to individuals with type 2 diabetes, with recommendations being the same for adults of all ages.[6] When comorbidities or age-related disabilities affect the ability to engage in PA, modifications may be needed with the aim of engaging in as much aerobic activity as health status allows.[6] Further, when comorbidities or disability prevent muscle-strengthening guidelines from being met, activity should focus on functional fitness, balance, and flexibility.[6] PA has the potential to improve cardiovascular risk factors and reduce adverse outcomes among those with diabetes, reducing the risk of cardiovascular disease, even when it is accompanied by little or no weight loss.[6] Regular aerobic PA improves glycemic control, resulting in 0.5%-0.7% reductions in Hemoglobin A1C.[6] Muscle-strengthening activity improves blood pressure, lipid profiles, and insulin sensitivity.[6] Engaging in both aerobic and muscle strengthening PA may provide more benefit in lowering A1C than either type of exercise alone.[4, 6] Further benefits of PA among those with diabetes include improvements in mental health and improving quality of life.[6]

Rural disparities in health behaviors, chronic disease, and socioeconomic status have been well documented. For example, diabetes prevalence and mortality are higher in non-metro counties compared to more urban counties.[10, 11, 12, 19] While diabetes mortality has improved in the US during the past two decades, rural counties have not improved as much as urban counties.[12, 19] This could be linked to higher rural prevalence of diabetes risk factors and lower prevalence of healthy behaviors. For example, obesity and cigarette smoking are more prevalent in more rural areas compared to urban areas.[20, 21] Meeting PA guidelines is also less common among the general adult population in rural counties.[13] The results of this study suggest that lower prevalence of meeting PA guidelines among adults with diabetes in non-metro areas may help to explain their continued higher diabetes mortality and further highlight the potential benefits of expanding rural access to diabetes

self-management programs and physical activity amenities to provide opportunities for leisure time physical activity.

Although the results suggest that lower rates of PA among those in rural areas may be at least partly explained by socioeconomic disparities experienced by rural residents, there is also evidence to suggest that rural residents experience different environmental factors that may influence PA compared to urban residents. For example, the lower population density generally associated with rural locations may result in fewer walkable or bikeable destinations. Specifically, Whitfield et al. reported in 2015 that rural residents were less likely to report the presence of walkable places such as retail stores, transit stops, recreational facilities, and places of worship, and more likely to report barriers to walking such as traffic and animals.[22] Residents from rural locations are also less likely to report infrastructure to facilitate walking or biking such as sidewalks, trails, or roads with adequate shoulders or bike lanes.[22] Access to diabetes management lifestyle intervention programs, which often include PA, may also be less available or a further distance from rural residents with diabetes.[23] Some research also suggests cultural norms may pose a barrier to PA in some rural places, such as Appalachia.[24] Finally, higher rural rates of diabetes complications[25] that pose significant barriers to PA such as amputations and proliferative retinopathy could also explain observed disparities in PA among rural adults with diabetes.

Limitations

There are several limitations to this study. First, only leisure time PA was measured, and participants may have also engaged in transportation or occupational PA. However, the evidence base demonstrating the chronic disease health benefits of PA is strongest with leisure PA rather than other forms of PA.[4] Second, the relatively low sample size of adults with diabetes across levels of urbanization impacted the statistical power to detect differences in PA according to urban/rural status as confidence interval of prevalence ratios tended to be wide. Third, because the study relied on self-report to assess diabetes status and PA, these variables may be subject to misclassification that could affect the results. Fourth, because of the cross-sectional nature of the study, it was not possible to assess the direction of causation between physical activity and diabetes. Fourth, because physical activity levels may have changed between 2020 and 2022, particularly considering the COVID-19 pandemic, the pooling of data from these two years may have resulted in prevalences that do not accurately reflect current physical activity levels. However, supplemental analysis suggests that prevalence of meeting guidelines did not differ by survey year among adults with diabetes, without diabetes, or from any county metropolitan status level. Fifth, because county metropolitan status is an imperfect proxy for urbanity as counties across metropolitan status classifications may contain both urban and rural territory and populations, the findings according to metropolitan status may not be generalizable to all counties in the US. Sixth, the exclusion of adults with missing data on diabetes status or physical activity may have resulted in selection bias, potentially limiting the generalizability of study findings. Lastly, changes to the study design of NHIS in 2019 limited the ability to compare findings of PA among adults with diabetes to previously published findings.

Conclusions

The results of the current study suggest that adults with diabetes still greatly lag those without diabetes in meeting PA guidelines. Further, disparities in meeting PA guidelines exist according to urban/rural status among both adults with and without diabetes. Among adults with and without diabetes, residence in a non-metro county was significantly associated with lower prevalence of meeting aerobic, strength, or both guidelines compared to residence in a large central metro county, although the association became non-significant among those with diabetes after multivariable adjustment. Encouraging adults with and without diabetes in rural areas to be more physically active using community based,[26] telehealth,[27] or other culturally tailored approaches for rural populations[8] may help mitigate disparities in type 2 diabetes incidence as well as diabetes mortality and complications.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This work was performed as part of normal employment duties at the Centers for Disease Control and Prevention with no external funding. No financial disclosures or conflicts of interest have been reported by the authors of this paper.

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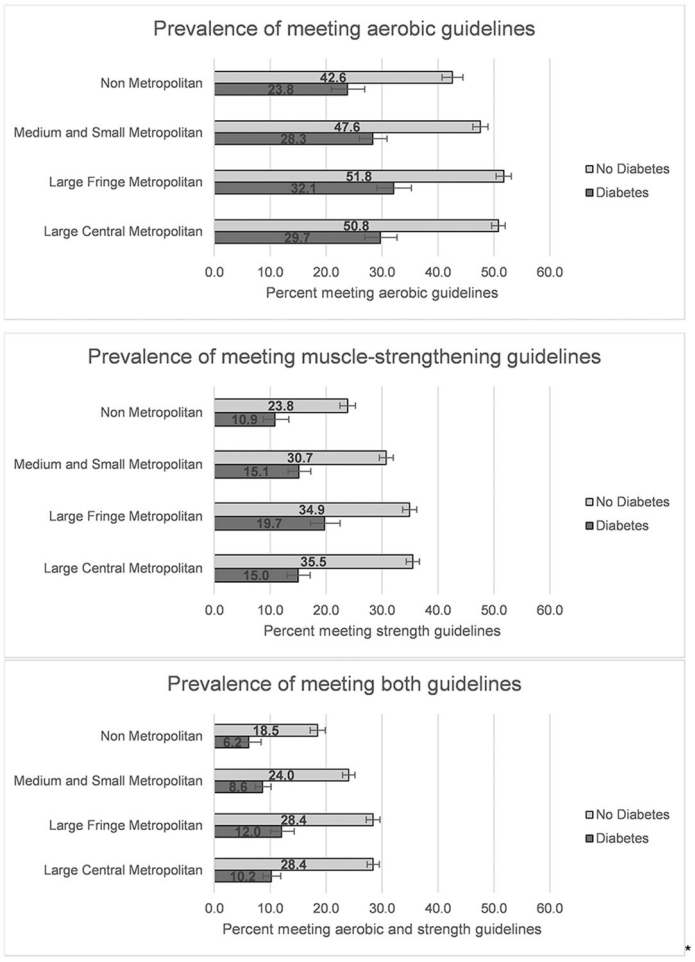

Figure 1. Age-Adjusted Prevalence and 95% Confidence Intervals of US Adults Meeting Physical Activity Guidelines for Aerobic Activity, Muscle-Strengthening Activity, and Both Guidelines According to Diabetes Status and County Metropolitan Status, 2020, 2022

All Chi-square tests comparing prevalence by county metropolitan status among those with diabetes and those without diabetes $p<0.001$.

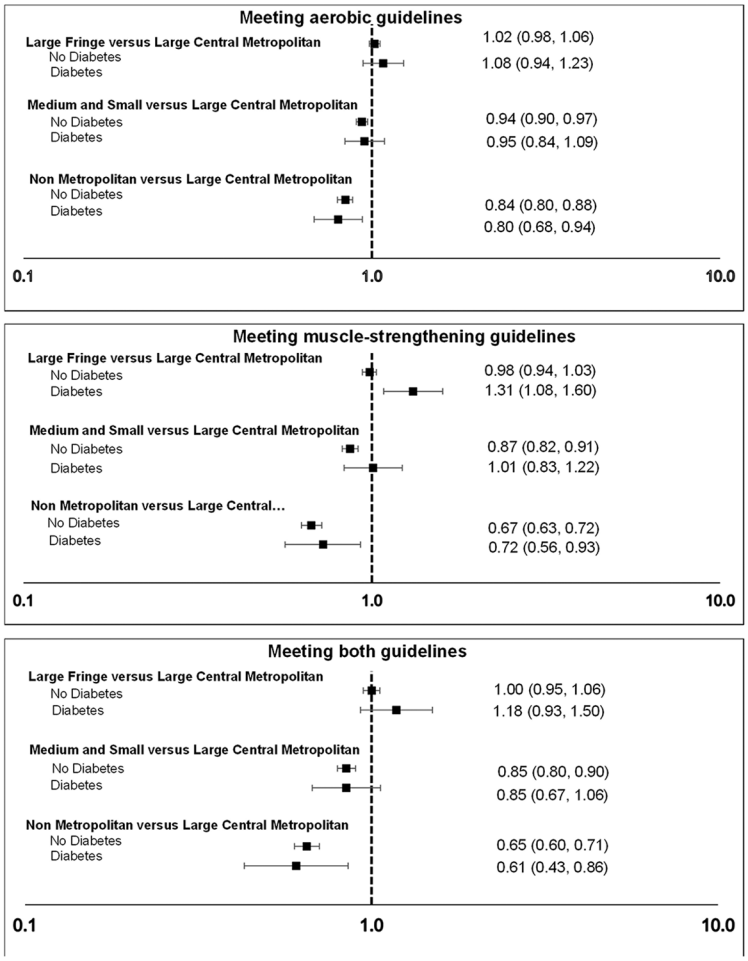

Figure 2. Age-Adjusted Prevalence Ratios and 95% Confidence Intervals Assessing the Prevalence of Meeting Physical Activity Guidelines Among Adults with and without Self-Reported Diabetes According to Urban-Rural Metropolitan Status

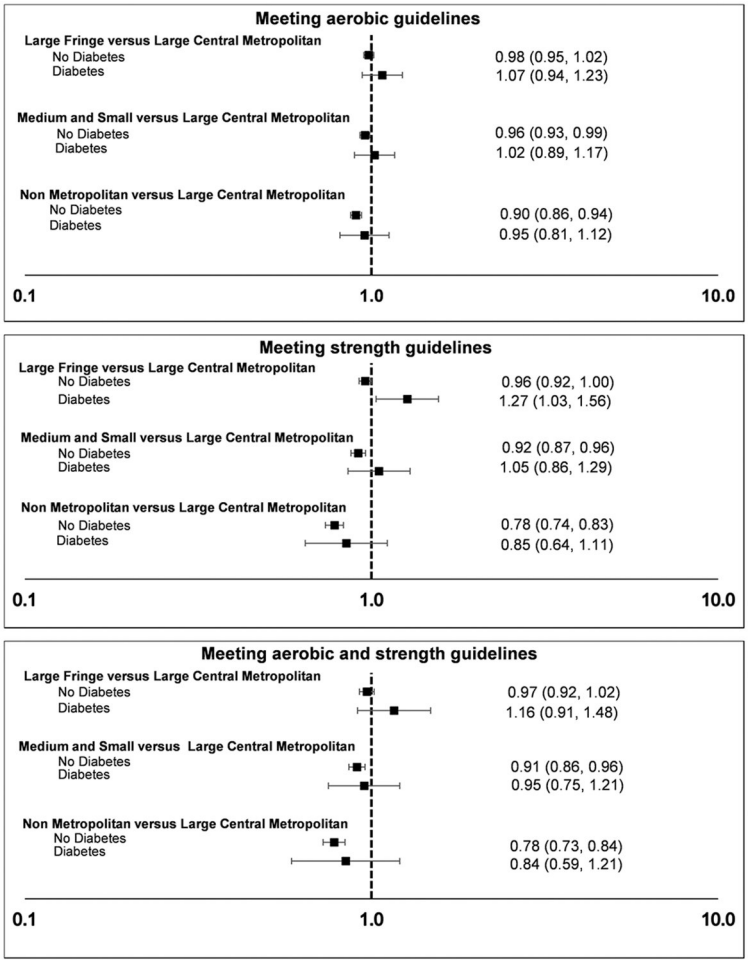

Figure 3. Multivariable-Adjusted[a] Prevalence Ratios and 95% Confidence Intervals Assessing the Prevalence of Meeting Physical Activity Guidelines Among Adults with and without Self-Reported Diabetes According to Urban-Rural Metropolitan Status

[a]Adjusted for age, sex, race/ethnicity, education, income to poverty ratio

Table 1.

Characteristics of the Study Population by Self-Report of Diagnosed Diabetes, United States, 2020, 2022

Characteristic	Total [a] (n=56,851)	Diabetes [a] (n=6,035)	No Diabetes [a] (n=50,816)	p-value[b]
Age, years				**<0.001**
18-44	45.7 (45.1, 46.4)	11.7 (10.6, 12.9)	49.2 (48.6, 49.9)	
45-64	32.3 (31.8, 32.8)	41.1 (39.5, 42.7)	31.4 (30.9, 31.9)	
65-74	13.1 (12.7, 13.4)	27.6 (26.3, 29.0)	11.6 (11.2, 11.9)	
75+	8.9 (8.6, 9.2)	19.6 (18.5, 20.8)	7.8 (7.5, 8.1)	
Sex				**<0.009**
Female	51.6 (51.1, 52.1)	48.9 (47.2, 50.5)	51.9 (51.4, 52.4)	
Male	48.4 (47.9, 48.9)	51.1 (49.5, 52.8)	48.1 (47.6, 48.6)	
Race and Ethnicity				**<0.001**
Hispanic	16.9 (15.7, 18.2)	18.2 (16.3, 20.4)	16.8 (15.6, 18.0)	
Non-Hispanic Asian	6.0 (5.5, 6.6)	6.4 (5.4, 7.5)	6.0 (5.5, 6.5)	
Non-Hispanic Black	11.5 (10.7, 12.4)	15.1 (13.6, 16.8)	11.2 (10.4, 12.0)	
Non-Hispanic White	62.8 (61.3, 64.3)	57.5 (55.2, 59.8)	63.4 (61.9, 64.8)	
Non-Hispanic Other	2.7 (2.3, 3.2)	2.8 (2.1, 3.7)	2.7 (2.3, 3.2)	
Education level				**<0.001**
<High School	11.1 (10.6, 11.6)	19.0 (17.5, 20.5)	10.3 (9.8, 10.8)	
High School Diploma/GED	27.5 (26.9, 28.2)	30.4 (28.9, 31.9)	27.3 (26.6, 27.9)	
Some College/Associate Degree	30.1 (29.5, 30.6)	30.7 (29.3, 32.2)	30.0 (29.4, 30.6)	
Bachelor’s Degree or Higher	31.3 (30.5, 32.2)	19.9 (18.7, 21.1)	32.5 (31.7, 33.4)	
Poverty-to-income ratio, weighted mean (95% CI)	4.2 (4.1, 4.2)	3.4 (3.3, 3.5)	4.3 (4.2, 4.3)	**<0.001**
Rural-urban classification				**<0.001**
Large Central Metro	30.9 (28.8, 33.1)	29.1 (26.6, 31.8)	31.1 (29.0, 33.3)	
Large Fringe Metro	25.0 (22.9, 27.3)	22.0 (19.6, 24.5)	25.3 (23.1, 27.6)	
Medium And Small Metro	30.1 (27.4, 32.9)	31.0 (28.0, 34.1)	30.0 (27.3, 32.8)	
Non-Metro	14.0 (13.0, 15.0)	17.9 (16.3, 19.7)	13.6 (12.6, 14.6)	
Met aerobic guidelines	47.1 (46.4, 47.8)	28.8 (27.3, 30.2)	49.0 (48.3, 49.7)	**<0.001**
Met muscle-strengthening guidelines	30.8 (30.1, 31.5)	15.3 (14.3, 16.5)	32.4 (31.7, 33.1)	**<0.001**
Met both guidelines	24.3 (23.7, 24.9)	9.4 (8.6, 10.3)	25.8 (25.2, 26.4)	**<0.001**

Note: Boldface indicates statistical significance (p<0.05)

[a] Weighted % (95% CI)

[b] Chi-square or t-test p-value comparing frequency of each variable according to diabetes status