Accepted Manuscript

Healthcare Providers' Advice on Lifestyle Modification in the US
Population: Results from the National Health and Nutrition
Examination Survey 2011-2016

Igor Grabovac MD, PhD , Lee Smith PhD ,
Sinisa Stefanac MScOT , Sandra Haider PhD , Chao Cao MPH ,
Thomas Waldhoer PhD , Sarah E. Jackson PhD , Lin Yang PhD

Healthcare Providers' Advice on Lifestyle Modification in the US Population: Results from the National Health and Nutrition Examination Survey 2011-2016

Igor Grabovac, MD, PhD[a], Lee Smith, PhD[b], Sinisa Stefanac, MScOT[c,d], Sandra Haider,PhD[a], Chao Cao, MPH[e], Thomas Waldhoer, PhD[f], Sarah E. Jackson, PhD[g], Lin Yang, PhD[f,h,i]

[a] Department of Social and Preventive Medicine, Center for Public Health, Medical University of Vienna, Kinderspitalgasse 15/1, 1090 Vienna, Austria; igor.grabovac@meduniwien.ac.at, sandra.a.haider@meduniwien.ac.at

[b] Cambridge Centre for Sport and Exercise Sciences, Anglia Ruskin University, Compass House, Cambridge CB1 1PT, UK; lee.smith@anglia.ac.uk

[c] Institute of Outcomes Research, Center for Medical Statistics, Informatics and Intelligent Systems, Medical University of Vienna, Spitalgasse 23, 1090 Vienna, Austria; sinisa.stefanac@meduniwien.ac.at

[d] Ludwig Boltzmann Cluster Arthritis and Rehabilitation, Nussdorfer Strasse 64, 1090 Vienna, Austria

[e] Division of Public Health Sciences, Department of Surgery, Washington University School of Medicine, 660 S. Euclid Avenue, St Louis, MO 63110-1093, USA; Caochao@wustl.edu

[f] Department of Epidemiology, Center for Public Health, Medical University of Vienna, Kinderspitalgasse 15/1, 1090 Vienna, Austria; thomas.waldhoer@meduniwien.ac.at; lin.yang@meduniwien.ac.at

[g] Department of Behavioral Science and Health, University College London, 1-19 Torrington Place, London WC1E 7HB, UK; s.e.jackson@ucl.ac.uk

[h] Department of Cancer Epidemiology and Prevention Research, Alberta Health Services, Holy Cross Centre, 2210-2nd Street SW, Box ACB, Calgary, AB, T2S 3C3, Canada.

[i] Preventive Oncology & Community Health Sciences, Cumming School of Medicine, University of Calgary, Hospital Drive NW, Calgary, Alberta, Canada

Correspondence to:

Sinisa Stefanac, MScOT, PG Cert

Institute of Outcomes Research

Center for Medical Statistics, Informatics and Intelligent Systems

Medical University of Vienna

Spitalgasse 23, 1090 Vienna

Austria

Telephone: 0043(1)40400-66610

Email: sinisa.stefanac@meduniwien.ac.at

Article type: Clinical research article

Key words: Healthcare provider advice; chronic condition; obesity; lifestyle modification; NHANES

Running head: Healthcare Providers' Advice on Lifestyle Modification

ABSTRACT

Objective: Healthcare providers are encouraged to prescribe lifestyle modifications for preventing and managing obesity and associated chronic conditions. However, the pattern of lifestyle advice provision is unknown. We investigate the prevalence of advised lifestyle modification according to weight status and chronic conditions in a US nationally representative sample.

Methods: Adults 20-64 years (n=11,467) from National Health and Nutrition Examination Study between 2011 and 2016 were analyzed, with weight status, and chronic conditions (high blood pressure, high blood cholesterol, osteoarthritis, coronary heart disease and type 2 diabetes mellitus). Lifestyle modification advice by healthcare providers included increase physical activity/exercise, reduce dietary fat/calories, control/lose weight, and all of above.

Results: High blood pressure (32.7%) and cholesterol (29.3%) were highly prevalent compared to osteoarthritis (7.4%), type 2 diabetes (5.7%) and coronary heart disease (3.7%). Those with type 2 diabetes received considerably frequent advice (56.5%; 95%CI: 52.4%-60.6%) than those with high blood pressure (31.4%; 95%CI:29.3%-33.6%) and cholesterol (27.0%; 95%CI:24.9%-29.3%). Prevalence of lifestyle advice exhibited substantial increases with graded BMI and comorbidity (all P<0.001). After adjusting for comorbid conditions, advice were more commonly reported among women, those overweight/obese, non-white, or insured. Remarkably low proportion of overweight (21.4: 95%CI: 18.7-24.3%) and obese (44.2%;95%CI:41.0%-47.4%) adults free of chronic conditions reported receiving any lifestyle advice.

Conclusions: Prevalence of lifestyle modification advised by healthcare providers is generally low among US adults with chronic conditions, and worryingly low among those without chronic conditions however overweight or obese. Prescribed lifestyle modification is a missing opportunity in implementing sustainably strategies reducing chronic condition burden.

3

Clinical significance

- Marked low proportions of overweight (22.4%) and obese (44.2%) Americans without chronic condition currently receive any lifestyle advice (exercise, reduced fat/calories, control/lose weight) from their healthcare providers.

- Despite being the most prevalent chronic conditions, below one third of Americans with high blood pressure or high cholesterol receive lifestyle advice.

- Prevalence of lifestyle advice increased with weight and comorbidity, meanwhile were considerately higher among women, overweight, obese, non-white, and insured Americans.

4

INTRODUCTION

Lifestyle factors such as suboptimal diet and physical inactivity (i.e. not meeting recommended physical activity guidelines) are recognized causes of overweight and obesity driving an undisputed public health challenge.[1] Obesity prevalence has been increasing worldwide,[2-5] bringing an increase of adiposity-related chronic conditions that increase the risk of premature mortality, morbidity, and long-term disability.[6 7] Obesity and its comorbid conditions are a problem of particular concern in the United States: in 2013, a report by the Institute of Medicine (IOM) documented the US being less healthy in key areas (including diabetes, obesity, heart disease, among others) compared to 16 other high income countries.[8] In 2015-2016, prevalence of obesity in US adults was 39.8%, continuing an upwards trend.[9] Rates of type 2 diabetes mellitus (T2DM),[10 11] coronary heart disease,[12 13] high blood cholesterol,[14] high blood pressure[15 16] and osteoarthritis[17 18] – prevalent chronic diseases with excess adiposity as an established cause – have also increased substantially in the US over recent decades.[19 20] With more than half of US adults reporting one chronic condition, and over a quarter having two or more, chronic diseases account for a large proportion of national health expenditure.[20]

To reduce this disease burden, weight control, increases in physical activity and improvements in diet are necessary through a range of clinic-, community, and environmental based approaches.[21] Community programs need to support health and strengthen the links between communities and healthcare providers in order to empower patients to better manage their health outside the clinical setting.[22] However, trends in increasing these protective factors (e.g. physical activity and blood pressure control) have stalled in recent years.[23]

Brief advice on lifestyle modification from healthcare providers appears to be an effective way of promoting health behaviour change.[24] A recent meta-analysis suggested that overweight/obese adults who received advice were near four times more likely to attempt to lose weight than those who received no such advice.[24 25] The importance of healthcare providers' giving patients lifestyle advice has been highlighted by international guidelines.[26 27] In 2012, the IOM summarised several population-based obesity prevention strategies, naming nutrition, weight and physical activity-related counselling by healthcare providers key strategies to provide standardized care and advocate for health in the community.[28] However, percentage of people with obesity

5

who are advised to manage their weight is unclear. Previous studies, mostly conducted around 10 years ago, reported low prevalence of lifestyle prescription in the US.[29-34] The current prevalence and patterns of HCPs' provision of advice for lifestyle modification is unknown.

Drawing on the recent nationally representative National Health and Nutrition Examination Survey (NHANES) 2011-2016 data, we describe for the first time the prevalence and patterns of healthcare providers advised lifestyle modification received by US adults according to their weight and chronic condition status. We restricted our sample to adults aged 20-64 years because majority of older adults (≥65 years) are US Medicare beneficiaries with differed health providers. This analysis 1) describe the prevalence of lifestyle advice among individuals free of chronic conditions, and those with high blood pressure, high blood cholesterol level, osteoarthritis, coronary heart disease and T2DM by weight status; 2) evaluate the associations between comorbidity and the likelihood of receiving healthcare providers' lifestyle advice; and 3) examine the correlates of receiving healthcare providers' lifestyle advice among US adults. Such information is crucial for understanding and informing clinical practice, priority-setting, and decision making across multiple levels of the healthcare system in chronic disease prevention and control.

MATERIALS AND METHODS

Study Population

NHANES was designed to provide cross-sectional estimates of the prevalence of health, nutrition, and potential risk factors among the civilian non-institutionalized US population[35] using a nationally representative complex, stratified, multistage, probability clustered sample. We extracted data on sociodemographic characteristics, body measurements, medical conditions, and lifestyle characteristics in the latest three waves from 2011-2012 to 2015-2016, and excluded those who were younger than 20 or 65 years and older, living with physical function limitation (walking for a quarter mile or walking up ten steps difficulty for adults), or pregnant.

Healthcare providers' advice on lifestyle modifications

6

Participants were asked "To lower your risk of certain disease, during the past 12 months have you ever been told by a doctor or health professional to: increase your physical activity or exercise / reduce the amount of fat or calories in your diet / control weight or lose weight?" Response options were yes (received lifestyle advice) and no (lifestyle advice not received). Participants reporting receiving all three lifestyle advice were also identified as a separate group owing to the stronger weight management effect of combined physical activity and diet changes than either one alone.[36]

Chronic conditions

Five highly prevalent chronic conditions that have excess adiposity as an established risk factor were included: high blood pressure, high blood cholesterol level, osteoarthritis, coronary heart disease and T2DM.

Participants with high blood pressure and cholesterol were identified using both self-reported and laboratory examinations. The details of blood pressure and laboratory cholesterol measurements are described elsewhere.[37][38] High blood pressure was determined if they were told they had high blood pressure or hypertension by a health professional, or the mean of at least 3 blood pressure measurements was 140 mm Hg or higher for systolic, or 90 mm Hg or higher for diastolic.[39] High blood cholesterol were determined by self-reported being told by health professional , or if their measured total cholesterol level was 6.2 mmol/L (240 mg/DL) or higher.[40] Osteoarthritis was determined by participant self-reporting being told they had osteoarthritis or degenerative arthritis by a health professional.[41] Coronary heart disease was defined based on participants' self-reported conditions of congestive heart failure, angina, heart attack, or coronary heart disease diagnosed. Structured interview questions on chest pain were further used to classify angina based on existing Rose angina criteria.[42] Participants were considered as having diabetes if they were told by a health professional or reported taking insulin.

Weight status

Weight and height were measured during a physical examination following standard procedures. Body mass index (BMI) was calculated as weight in kg/(height in meters)^2 and categorized into: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obesity (≥30 kg/m^2) based on the

7

standard classification.[43] For analytic purposes, we exclude those who were underweight due to potential underlying health conditions.

Covariates

Self-reported socio-demographic characteristics included age, gender, race and ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, and others), annual household income ($25,000 or less, $25,000 to $74,999, and $75,000 or above), insurance (uninsured, insured with public insurance, and insured with private insurance) and education (less than high school, high school, and above high school). Lifestyle characteristics included leisure time physical activity and smoking status. Participants reported the number of days and minutes spent in moderate recreational and vigorous recreational activities in a typical week. We summarized the total number of minutes for both activities and classified participants as inactive (zero moderate-to-vigorous physical activity), and active (any moderate-to-vigorous physical activity) based on the physical activity guideline.[44] Smoking status was classified into never smokers (did not smoke 100 cigarettes and do not smoke now), former smokers (smoked 100 cigarettes in life and do not smoke now), and current smokers (smoked 100 cigarettes in life and smoke now).

Analysis

All statistical analyses were performed using STATA version 14.0 (STATA Corp., College Station, Texas, USA). Survey analysis procedures were used to account for the sample weights, stratification, and clustering of the complex sampling design to ensure nationally representative estimates.[45] We calculated weighted proportion of participants receiving lifestyle advice for each morbidity condition in overall population and by BMI category.. Additionally, we calculated the weighted proportion of participants who currently not receiving any lifestyle modification advice from their healthcare providers according to morbidity condition and BMI category.

We estimated the unadjusted and multivariable adjusted associations of chronic condition (free or chronic condition, one chronic condition, comorbidity) with the likelihood of receiving lifestyle advice in each BMI category using odds ratios (ORs). Finally, multivariable adjusted logistic regressions were used to identify correlates for receiving lifestyle advice while modelling chronic conditions as a categorical variable (0 indicates

8

free of chronic conditions, and 1-5 indicate each chronic condition). Multivariate adjustments include age (continuous), gender, BMI category, race/ethnicity, household income, health insurance status, leisure time physical activity, education level, and smoking status. All statistical significance was set at *P*<0.05. P-values were not adjusted for multiple tests and should be interpreted explanatorily only.

RESULTS

Overall, data on 11 467 (weighted n= 31 142 531) adults were included in the analysis. Table 1 presents the unweighted sample size of chronic conditions in the US population overall and by gender, BMI, race/ethnicity and smoking status. The most prevalent chronic conditions were high blood cholesterol (weighted proportion 32.7%) and high blood pressure (weighted proportion 29.3%) followed by osteoarthritis (7.4%), T2DM (5.7%) and coronary heart disease (3.7%). Up to 20.7% of the adult population (20-64 years) had at least two coexisting chronic conditions.

Prevalence of healthcare providers' advice on lifestyle modifications

Despite its relative low prevalence, adults with T2DM received lifestyle advice most often (56.5%, 95%CI: 52.4-60.6%), followed by those with coronary heart disease (34.6%, 95%CI: 28.9%-40.7%) and osteoarthritis (34.9%, 95%CI: 31.0-39.1%). In contrast, adults living with highly prevalent chronic conditions such as high blood pressure and cholesterol received lifestyle advice less frequently (31.4%, 95%CI: 29.3%-33.6% and 27.0%, 95%CI: 24.9-29.3%, respectively) (Table 2). This pattern was consistently observed within each BMI category (Table 2 and Figure 1). The prevalence of lifestyle advice was the lowest among individuals free of chronic conditions. Among normal weight adults who were free of chronic conditions, only 9.8% (95%CI: 8.2%-11.8%) were advised to exercise and 1% (95%CI: 0.4%-2.2%) received all advice. Overweight and obese adults free of chronic conditions received lifestyle advice more frequently than normal weight individuals, with 22.4% (95%CI: 18.7%-24.3%) overweight and 44.2% (95%CI: 41.0%-47.4%) obese adults received at least one lifestyle advice, however leaving 78.6% and 55.8% of this group of adults completely absent of any lifestyles advice (Supple table 1). Among those free of chronic conditions, despite being obese, only 37.1%

9

(95%CI: 33.9%-40.5%) were advised to exercise, 27.2% (95%CI: 22.4%-31.1%) were advised to reduce fat or calorie intake, and 33.8% (95%CI: 31.3%-36.5%) were advised to control or lose weight (Table 2, Figure 1).

Comorbidity and healthcare providers' advice on lifestyle modifications

For each lifestyle advice, prevalence increased with graded BMI across all chronic condition statuses (Figure 1). In each BMI category, prevalence of being advised to exercise and reduce fat/calories exhibited substantial increases with comorbidity (all P values for trend <.001) adjusting for age, gender, race/ethnicity, household income, health insurance status, leisure time physical activity, education level and smoking status (Table 3). Among overweight and obese participants, there was an increased trend of being advised to control/lose weight with comorbidity (both P values for trend <.001). While the odds of receiving an advice to control/lose weight were not significantly higher among normal weight adults with one chronic condition compared to those who were free of chronic conditions (OR=1.2, 95%CI: 0.6-2.2), having two or more comorbidities was associated with markedly higher odds of being advised to control/lose weight (OR=5.0, 95%CI: 2.5-10.1) (Table 3).

Multivariable-adjusted logistic regression identified a few correlates for lifestyle advice. After adjusting for all chronic conditions, healthcare providers' advice on lifestyle modification were consistently more commonly reported among women, graded BMI, non-white race/ethnicity , and being insured, regardless of non-private or private insurance (all P values <.004) (Table 4).

DISCUSSION

We quantify the cross-sectional relationship of weight-associated chronic conditions with healthcare provider's advice on lifestyle modification in a contemporary nationally representative sample of US adults 20 to 64 years old. High blood pressure and cholesterol were particularly prevalent compared to osteoarthritis, T2DM and coronary heart disease. However, participants with T2DM and coronary heart disease were most likely to receive lifestyle advice. The prevalence of lifestyle advice increased with BMI for each included chronic condition, and increased dramatically with number of comorbidity. After adjusting for all comorbid conditions,

10

receiving lifestyle advice was more frequently reported among women, and those who were overweight or obese, non-white, or insured.

A recent CDC study used National Health Interview Survey data evaluating trends of weight loss counselling among patients with arthritis, reporting 23.8% overweight and 62.8% obese adults with arthritis receiving weight loss counselling .[46] Albeit approximately agreeing with our findings, their study did not distinguish types of advice given, precluding a clear comparison.

Importantly, our analyses released that fewer than 20% of overweight and less than 40% of obese adults received any lifestyle modification advice when free of chronic disease, demonstrating that most healthcare providers are missing this crucial primary prevention opportunity as recommended by numerous guidelines.[26-28] Although the low prevalence of lifestyle advice is a cause for concern, it is still more encouraging than the critical low weight management advice (2.6%) reported by Lutfiyya et al in 2008.[30] In fact, previous studies mostly included single lifestyle advice, or single chronic condition, possible due to the lack of systematically collected data.[29-34] For the first time, our study mapped out the contemporary patterns of multiple lifestyle modifications advised by healthcare providers and systematically evaluated their patterns according to a number of prevalent chronic conditions, revealing alarmingly low rates of lifestyle advice available to US adults in the healthcare setting.

The reasons for low rates of advice provided is possibly related to general pessimism of healthcare providers concerning the success of weight loss strategies. Primary care physicians in the US likely to consider obesity treatments   as less effective than treatment of all chronic issues.[47] Physicians also quote lack of confidence and skills and perceiving the problems as too complex.[48] Meanwhile, this kind of disillusionment has been identified as a barrier in providing the necessary recommendations.[49] Another factor that may discourage physicians from broaching the topic of lifestyle modification is perceived lack of time, yet studies have shown that counselling sessions of as little as 5 minutes[50 51] or even 30 seconds[52] could be effective. Fears that patients will find such interventions rude were also unfounded as under 1% of patients found this kind of opportunistic intervention as inappropriate.[52]

11

Our findings on healthcare providers' advice on lifestyle modification being more commonly reported among women, overweight or obese adults, non-white, or insured US population are in accord with a previous study of around 1700 obese Mexican-American adults.[31] Their study reported that men, unmarried individuals, those less educated and preferred to talk Spanish at home and without comorbidities were less likely to receive lifestyle modification advice. The disparate pattern observed in our analyses indicates the needs to strengthen the implementation of lifestyle modification advice, particularly among men. Meanwhile community-based lifestyle modification support should be designed accessible to the uninsured.

The rising trends in overweight and obesity, as well as associated chronic conditions in the US population, warrant timely attention from health policy and health care system decision makers. The management of chronic conditions is complex and requires multi-level approaches through individual, health professional, community, environment and policy engagement. The rapid increase in population weight and associated chronic conditions calls for greater efforts adopting population-based strategies to reduce modifiable risk factors in a favourable direction in the population. Primary care efforts are urgently needed for preventing and treating obesity as well as altering societal norms.[53 54] In 2012, the IOM identified several population-based obesity prevention strategies that target physical activity, healthy diet, and shaping healthy social norms, as well as provided recommendations on setting-specific implementations of the strategies to combat obesity.[28] Nutrition, weight counselling and physical activity-related counselling by healthcare providers were listed as key strategies to provide standardized care and advocate for healthy community environment.[28] They also summarize specific key metrics to evaluate the progress of obesity prevention strategies towards sustainable implementation.[55] Delivering these strategies is a priority to reduce the burden of obesity on contemporary and future generations.

Conclusion

Prevalence of healthcare providers' advice on lifestyle modification is low among US adults with obesity-associated chronic conditions, with worryingly low proportions of US adults free from chronic conditions receives any lifestyle advice. Healthcare provider prescribed lifestyle modifications, a sustainable strategy in reducing burden of obesity and chronic condition, should be widely implemented. Our findings highlight a

substantial window of opportunity to increase preventive efforts. In addition, we identified a need for lifestyle

modification support to be accessible to the uninsured population through community engagement in the US.

REFERENCES:

1. Mooney H. Doctors are told to "make every contact count" to reduce costs of poor lifestyles. *BMJ (Clinical research ed)* 2012;344:e319. doi: 10.1136/bmj.e319 [published Online First: 2012/01/12]
2. James WP. WHO recognition of the global obesity epidemic. *International journal of obesity (2005)* 2008;32 Suppl 7:S120-6. doi: 10.1038/ijo.2008.247 [published Online First: 2009/01/16]
3. Low S, Chin MC, Deurenberg-Yap M. Review on epidemic of obesity. *Annals of the Academy of Medicine, Singapore* 2009;38(1):57-9. [published Online First: 2009/02/18]
4. Whitlock G, Lewington S, Sherliker P, et al. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet* 2009;373(9669):1083-96. doi: 10.1016/s0140-6736(09)60318-4 [published Online First: 2009/03/21]
5. Flegal KM, Carroll MD, Kit BK, et al. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA* 2012;307(5):491-7. doi: 10.1001/jama.2012.39 [published Online First: 2012/01/19]
6. Kushner RF, Foster GD. Obesity and quality of life. *Nutrition (Burbank, Los Angeles County, Calif)* 2000;16(10):947-52. [published Online First: 2000/10/31]
7. Visscher TL, Seidell JC. The public health impact of obesity. *Annu Rev Public Health* 2001;22:355-75. doi: 10.1146/annurev.publhealth.22.1.355 [published Online First: 2001/03/29]
8. Woolf SH, Aron LY. The US health disadvantage relative to other high-income countries: findings from a National Research Council/Institute of Medicine report. *JAMA* 2013;309(8):771-2. doi: 10.1001/jama.2013.91 [published Online First: 2013/01/12]
9. Hales CM, Carroll MD, Fryar CD, et al. Prevalence of Obesity Among Adults and Youth: United States, 2015-2016: Centers for Disease Control and Prevention, National Center for Health Statistics; 2017 Available from: https://www.cdc.gov/nchs/data/databriefs/db288.pdf Accessed October 15 2018.
10. Colditz GA, Willett WC, Rotnitzky A, et al. Weight gain as a risk factor for clinical diabetes mellitus in women. *Ann Intern Med* 1995;122(7):481-6. [published Online First: 1995/04/01]
11. Vazquez G, Duval S, Jacobs DR, Jr., et al. Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: a meta-analysis. *Epidemiol Rev* 2007;29:115-28. doi: 10.1093/epirev/mxm008 [published Online First: 2007/05/12]
12. Canoy D. Distribution of body fat and risk of coronary heart disease in men and women. *Current opinion in cardiology* 2008;23(6):591-8. doi: 10.1097/HCO.0b013e328313133a [published Online First: 2008/10/03]
13. Metabolic mediators of the effects of body-mass index, overweight, and obesity on coronary heart disease and stroke: a pooled analysis of 97 prospective cohorts with 1.8 million participants. *Lancet* 2013 doi: 10.1016/s0140-6736(13)61836-x [published Online First: 2013/11/26]
14. Gostynski M, Gutzwiller F, Kuulasmaa K, et al. Analysis of the relationship between total cholesterol, age, body mass index among males and females in the WHO MONICA Project. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity* 2004;28(8):1082-90. doi: 10.1038/sj.ijo.0802714 [published Online First: 2004/06/24]
15. Kristjansson K, Sigurdsson JA, Lissner L, et al. Blood pressure and pulse pressure development in a population sample of women with special reference to basal body mass and distribution of body fat and their changes during 24 years. *International journal of obesity and related metabolic disorders : journal*

of the International Association for the Study of Obesity 2003;27(1):128-33. doi: 10.1038/sj.ijo.0802190 [published Online First: 2003/01/18]

16. Droyvold WB, Midthjell K, Nilsen TI, et al. Change in body mass index and its impact on blood pressure: a prospective population study. *International journal of obesity (2005)* 2005;29(6):650-5. doi: 10.1038/sj.ijo.0802944 [published Online First: 2005/04/06]

17. Felson DT. Weight and osteoarthritis. *Am J Clin Nutr* 1996;63(3 Suppl):430s-32s. doi: 10.1093/ajcn/63.3.430 [published Online First: 1996/03/01]

18. Cooper C, Inskip H, Croft P, et al. Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity. *Am J Epidemiol* 1998;147(6):516-22. [published Online First: 1998/04/01]

19. Barbour KE, Helmick CG, Boring M, et al. Vital Signs: Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation - United States, 2013-2015. *MMWR Morb Mortal Wkly Rep* 2017;66(9):246-53. doi: 10.15585/mmwr.mm6609e1 [published Online First: 2017/03/10]

20. Bauer UE, Briss PA, Goodman RA, et al. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. *Lancet* 2014;384(9937):45-52. doi: 10.1016/S0140-6736(14)60648-6 [published Online First: 2014/07/06]

21. Blair SN, Horton E, Leon AS, et al. Physical activity, nutrition, and chronic disease. *Medicine and science in sports and exercise* 1996;28(3):335-49. [published Online First: 1996/03/01]

22. Pearson TA, Palaniappan LP, Artinian NT, et al. American Heart Association Guide for Improving Cardiovascular Health at the Community Level, 2013 update: a scientific statement for public health practitioners, healthcare providers, and health policy makers. *Circulation* 2013;127(16):1730-53. doi: 10.1161/CIR.0b013e31828f8a94 [published Online First: 2013/03/23]

23. Johnson NB, Hayes LD, Brown K, et al. CDC National Health Report: leading causes of morbidity and mortality and associated behavioral risk and protective factors--United States, 2005-2013. *MMWR Suppl* 2014;63(4):3-27. [published Online First: 2014/10/31]

24. Rose SA, Poynter PS, Anderson JW, et al. Physician weight loss advice and patient weight loss behavior change: a literature review and meta-analysis of survey data. *International journal of obesity (2005)* 2013;37(1):118-28. doi: 10.1038/ijo.2012.24 [published Online First: 2012/03/28]

25. Heaton PC, Frede SM. Patients' need for more counseling on diet, exercise, and smoking cessation: results from the National Ambulatory Medical Care Survey. *J Am Pharm Assoc (2003)* 2006;46(3):364-9. [published Online First: 2006/06/03]

26. Moyer VA, on behalf of the USPSTF. Screening for and management of obesity in adults: U.s. preventive services task force recommendation statement. *Annals of Internal Medicine* 2012;157(5):373-78. doi: 10.7326/0003-4819-157-5-201209040-00475

27. NICE. Weight management: lifestyle services for overweight or obese adults. Public health guidline 53 (PH53). London: National Institute for Health and Care Excellence, 2014.

28. Institute of Medicine. Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation. Washington, DC: The National Academies Press, 2012.

29. Ko JY, Brown DR, Galuska DA, et al. Weight loss advice U.S. obese adults receive from health care professionals. *Prev Med* 2008;47(6):587-92. doi: 10.1016/j.ypmed.2008.09.007 [published Online First: 2008/10/15]

30. Lutfiyya MN, Nika B, Ng L, et al. Primary prevention of overweight and obesity: an analysis of national survey data. *J Gen Intern Med* 2008;23(6):821-3. doi: 10.1007/s11606-008-0581-5 [published Online First: 2008/03/20]

31. Nguyen HT, Markides KS, Winkleby MA. Physician advice on exercise and diet in a U.S. sample of obese Mexican-American adults. *Am J Health Promot* 2011;25(6):402-9. doi: 10.4278/ajhp.090918-QUAN-305 [published Online First: 2011/07/05]

32. Noordman J, Verhaak P, van Dulmen S. Discussing patient's lifestyle choices in the consulting room: analysis of GP-patient consultations between 1975 and 2008. *BMC Family Practice* 2010;11:87-87. doi: 10.1186/1471-2296-11-87

33. Shiffman S, Sweeney CT, Pillitteri JL, et al. Weight management advice: what do doctors recommend to their patients? *Prev Med* 2009;49(6):482-6. doi: 10.1016/j.ypmed.2009.09.015 [published Online First: 2009/09/30]

34. Simkin-Silverman LR, Gleason KA, King WC, et al. Predictors of weight control advice in primary care practices: patient health and psychosocial characteristics. *Prev Med* 2005;40(1):71-82. doi: 10.1016/j.ypmed.2004.05.012 [published Online First: 2004/11/09]

35. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey. http://www.cdc.gov/nchs/nhanes.htm. Accessed February 10, 2014 [

36. Johns DJ, Hartmann-Boyce J, Jebb SA, et al. Diet or exercise interventions vs combined behavioral weight management programs: a systematic review and meta-analysis of direct comparisons. *Journal of the Academy of Nutrition and Dietetics* 2014;114(10):1557-68. doi: 10.1016/j.jand.2014.07.005 [published Online First: 2014/09/27]

37. Zipl G, Chiappa M, Porter KS, et al. National Health and Nutrition Examination Survey: Plan and operations, 1999-2010: National Center for Health Statistics. Vital Health Stat 1(56), 2013.

38. Centers for Disease Control and Preventation. National Health and Nutrtion Examination Survey (NHANES) Laboratory Procedures Manual: Atlanta, GA: CDC, 2011.

39. Muntner P, Carey RM, Gidding S, et al. Potential U.S. Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline. *J Am Coll Cardiol* 2018;71(2):109-18. doi: 10.1016/j.jacc.2017.10.073 [published Online First: 2017/11/18]

40. Gregg EW, Cheng YJ, Cadwell BL, et al. Secular trends in cardiovascular disease risk factors according to body mass index in US adults. *Jama* 2005;293(15):1868-74. doi: 10.1001/jama.293.15.1868 [published Online First: 2005/04/21]

41. Liu SH, Eaton CB, Driban JB, et al. Comparison of self-report and objective measures of physical activity in US adults with osteoarthritis. *Rheumatology international* 2016;36(10):1355-64. doi: 10.1007/s00296-016-3537-9 [published Online First: 2016/07/21]

42. Rose GA, Blackburn H. Cardiovascular Survey Methods. Geneva, Switzerland: World Health Organization WHO Publications, 1982.

43. NHLBI Obesity Task Force. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults - the evidence report. *Obes Res* 1986;6(supp 2):51S-209S.

44. CDC. Physical activity guidelines for adults. Atlanta, 2011.

45. Curtin LR, Mohadjer LK, Dohrmann SM, et al. The National Health and Nutrition Examination Survey: Sample Design, 1999-2006. *Vital and health statistics Series 2, Data evaluation and methods research* 2012(155):1-39. [published Online First: 2012/07/14]

46. Guglielmo D, Hootman JM, Murphy LB, et al. Health Care Provider Counseling for Weight Loss Among Adults with Arthritis and Overweight or Obesity - United States, 2002-2014. *MMWR Morb Mortal Wkly Rep* 2018;67(17):485-90. doi: 10.15585/mmwr.mm6717a2 [published Online First: 2018/05/04]

47. Foster GD, Wadden TA, Makris AP, et al. Primary care physicians' attitudes about obesity and its treatment. *Obes Res* 2003;11(10):1168-77. doi: 10.1038/oby.2003.161 [published Online First: 2003/10/22]

48. Leverence RR, Williams RL, Sussman A, et al. Obesity counseling and guidelines in primary care: a qualitative study. *Am J Prev Med* 2007;32(4):334-39. doi: 10.1016/j.amepre.2006.12.008 [published Online First: 2007/03/27]

49. Jackson JE, Doescher MP, Saver BG, et al. Trends in Professional Advice to Lose Weight Among Obese Adults, 1994 to 2000. *Journal of General Internal Medicine* 2005;20(9):814-18. doi: 10.1111/j.1525-1497.2005.0172.x

50. Albright CL, Cohen S, Gibbons L, et al. Incorporating physical activity advice into primary care: physician-delivered advice within the activity counseling trial. *Am J Prev Med* 2000;18(3):225-34. [published Online First: 2000/03/21]

51. Rippe JM, McInnis KJ, Melanson KJ. Physician involvement in the management of obesity as a primary medical condition. *Obes Res* 2001;9 Suppl 4:302S-11S. doi: 10.1038/oby.2001.135 [published Online First: 2001/11/15]

15

52. Aveyard P, Lewis A, Tearne S, et al. Screening and brief intervention for obesity in primary care: a parallel, two-arm, randomised trial. *The Lancet* 2016;388(10059):2492-500. doi: 10.1016/S0140-6736(16)31893-1

53. Rose G. Sick individuals and sick populations. *International journal of epidemiology* 1985;14(1):32-8. [published Online First: 1985/03/01]

54. Doyle YG, Furey A, Flowers J. Sick individuals and sick populations: 20 years later. *J Epidemiol Community Health* 2006;60(5):396-8. doi: 10.1136/jech.2005.042770 [published Online First: 2006/04/15]

55. Institute of Medicine. Evaluating Obesity Prevention Efforts: A Plan for Measuring Progress. Washington, DC: The National Academies Press, 2013.

Figure 1. Weighted Prevalence of Healthcare Providers' Advice on Lifestyle Modification According to Chronic Condition in US Adults 20-64 Years Old, NHANES 2011-2016[a]

[a] All estimates were weighted to be nationally representative.

17
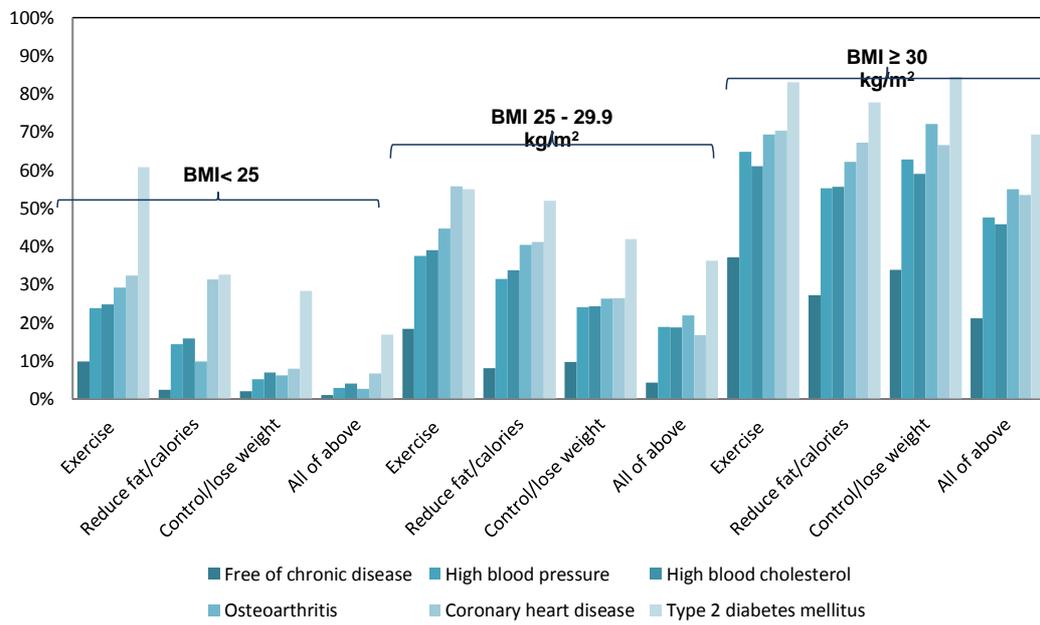
Table 1. Sample Size for Chronic Condition Status in the US Adults 20-64 Years, NHANES 2011-2016 [a]

	Free of chronic condition [b]	High blood pressure	High blood cholesterol	Osteoarthritis	Type 2 diabetes mellitus	Coronary heart disease	Comorbidity (≥2)
Overall	5617	3599	3693	690	829	496	2474
Gender							
Men	2665	1885	1977	276	430	254	1276
Women	2952	1714	1716	414	399	242	1198
BMI							
<25 kg/m2	2320	630	822	132	102	86	382
25 - <30 kg/m^2	1703	1059	1310	183	217	141	765
≥30 kg/m2	1594	1910	1561	375	510	269	1327
Race/ethnicity							
Non-Hispanic white	1875	1134	1273	353	193	179	828
Non-Hispanic black	1160	1139	789	142	237	138	699
Hispanic	1459	866	1023	128	285	131	641
Asian	932	336	496	31	87	30	228
Other	191	124	112	36	27	18	78
Health insurance status							
Uninsured	1697	802	780	98	170	101	471
Non-private insurance	971	978	821	219	255	228	732
Private insurance	2945	1817	2088	373	404	167	1270
Smoking status							
Never	3702	1897	2053	325	451	198	1252
Former	753	808	860	181	217	127	625
Current	1162	894	780	184	161	171	597

[a] Free of high blood pressure, high blood cholesterol, osteoarthritis, type 2 diabetes, coronary heart disease

Table 2. Weighted Prevalence (%) of Healthcare Providers' Advice on Lifestyle Modification according to Chronic Condition Status in US Adults 20-64 years, NHANES 2011-2016

	Exercise			Reduce fat/calories			Control/lose weight			All of above		
Free of chronic disease	**20.1**	**(18.4 to**	**21.9)**	**11.1**	**(9.7 to**	**12.7)**	**13.3**	**(11.8 to**	**14.9)**	**7.7**	**(6.7 to**	**8.8)**
<25 kg/m2	9.8	(8.2 to	11.8)	2.5	(1.7 to	3.6)	2.0	(1.3 to	3.1)	1.0	(0.4 to	2.2)
25 - <30 kg/m^2	18.3	(15.9 to	21.0)	8.0	(6.4 to	10.0)	9.7	(7.8 to	12.0)	4.3	(3.1 to	5.7)
≥30 kg/m2	37.1	(33.9 to	40.5)	27.2	(24.4 to	30.1)	33.8	(31.3 to	36.5)	21.2	(19.0 to	23.6)
P for trend	< .001			< .001			< .001			< .001		
High blood pressure	**49.7**	**(47.2 to**	**52.3)**	**41.3**	**(39.1 to**	**43.5)**	**41.4**	**(39.0 to**	**43.8)**	**31.4**	**(29.3 to**	**33.6)**
<25 kg/m2	23.9	(19.9 to	28.4)	14.3	(11.4 to	17.8)	5.2	(3.3 to	7.9)	2.9	(1.7 to	4.9)
25 - <30 kg/m^2	37.6	(32.6 to	42.7)	31.5	(27.2 to	36.0)	24.0	(19.7 to	28.9)	18.9	(15.3 to	23.1)
≥30 kg/m2	64.8	(61.2 to	68.3)	55.3	(52.2 to	58.4)	62.7	(60.2 to	65.2)	47.6	(44.3 to	50.9)
P for trend	< .001			< .001			< .001			< .001		
High blood cholesterol	**45.3**	**(42.7 to**	**47.8)**	**39.2**	**(37.1 to**	**41.3)**	**35.2**	**(32.8 to**	**37.7)**	**27.0**	**(24.9 to**	**29.3)**
<25 kg/m2	24.8	(20.5 to	29.6)	15.9	(12.4 to	20.0)	7.0	(4.5 to	10.6)	4.0	(2.5 to	6.3)
25 - <30 kg/m^2	39.1	(34.7 to	43.6)	33.7	(30.0 to	37.6)	24.2	(20.8 to	28.1)	18.8	(15.5 to	22.6)
≥30 kg/m2	61.0	(57.3 to	64.6)	55.6	(52.7 to	58.5)	59.1	(55.9 to	62.1)	45.8	(42.4 to	49.3)
P for trend	< .001			< .001			< .001			< .001		
Osteoarthritis	**54.2**	**(49.8 to**	**58.4)**	**45.5**	**(41.2 to**	**49.8)**	**45.6**	**(40.8 to**	**50.4)**	**34.9**	**(31.0 to**	**39.1)**
<25 kg/m2	29.2	(19.8 to	40.8)	9.9	(4.9 to	18.8)	6.2	(2.3 to	15.7)	2.7	(0.5 to	13.1)
25 - <30 kg/m^2	44.6	(36.5 to	53.0)	40.4	(30.2 to	51.5)	26.3	(18.9 to	35.4)	21.9	(15.1 to	30.7)
≥30 kg/m2	69.4	(63.1 to	75.0)	62.1	(55.8 to	68.1)	72.1	(67.1 to	76.6)	55.1	(48.4 to	61.6)
P for trend	< .001			< .001			< .001			< .001		
Coronary heart disease	**59.3**	**(51.8 to**	**66.3)**	**53.3**	**(47.8 to**	**58.8)**	**44.5**	**(38.2 to**	**51.0)**	**34.6**	**(28.9 to**	**40.7)**
<25 kg/m2	32.4	(20.7 to	46.8)	31.3	(19.1 to	46.8)	8.0	(2.8 to	21.0)	6.7	(1.9 to	20.5)
25 - <30 kg/m^2	55.8	(43.6 to	67.3)	41.1	(30.2 to	53.0)	26.4	(18.8 to	35.7)	16.7	(10.9 to	24.8)
≥30 kg/m2	70.3	(62.3 to	77.2)	67.3	(59.8 to	73.9)	66.5	(58.2 to	74.0)	53.5	(46.2 to	60.7)
P for trend	< .001			< .001			< .001			< .001		
Type 2 diabetes mellitus	**74.6**	**(69.8 to**	**78.8)**	**67.3**	**(62.7 to**	**71.6)**	**69.2**	**(64.6 to**	**73.5)**	**56.5**	**(52.4 to**	**60.6)**
<25 kg/m2	60.7	(46.1 to	73.6)	32.7	(20.9 to	47.1)	28.3	(16.5 to	44.1)	16.9	(8.6 to	30.6)
25 - <30 kg/m^2	55.0	(45.9 to	63.8)	51.9	(44.2 to	59.6)	41.9	(33.2 to	51.2)	36.2	(28.0 to	45.3)
≥30 kg/m2	83.0	(77.3 to	87.6)	77.8	(71.0 to	83.3)	84.4	(78.7 to	88.8)	69.4	(63.4 to	74.7)
P for trend	< .001			< .001			< .001			< .001		

[a] All estimates were weighted to be nationally representative.

19

Table 3. Weighted Multivariable Adjusted Logistic Regression Models of Comorbidity and Healthcare Provider Advised Lifestyle Modification in the US Adults 20-64 Years, NHANES 2011-2016[a,b]

Comorbidity	Exercise		Reduce fat/calories		Control/lose weight		All of above	
	BMI <25 kg/m²							
Free of chronic disease	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
One	1.8	(1.3 to 2.5)	3.6	(2.1 to 6.3)	1.2	(0.6 to 2.2)	1.2	(0.4 to 3.4)
Two or more	3.9	(2.5 to 6.1)	8.3	(5.1 to 13.5)	5.0	(2.5 to 10.1)	3.9	(1.5 to 9.8)
P for trend	<.001		<.001		<.001		0.001	
	BMI 25 - 29.9 kg/m²							
Free of chronic disease	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
One	1.9	(1.5 to 2.5)	3.4	(2.4 to 4.7)	2.3	(1.6 to 3.1)	3.6	(2.2 to 6.0)
Two or more	4.4	(3.2 to 6.0)	8.9	(6.5 to 12.0)	4.2	(3.1 to 5.6)	8.0	(5.0 to 12.7)
P for trend	<.001		<.001		<.001		<.001	
	BMI ≥30 kg/m²							
Free of chronic disease	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
One	1.7	(1.4 to 2.0)	1.7	(1.3 to 2.1)	1.6	(1.3 to 1.9)	1.6	(1.3 to 2.1)
Two or more	4.0	(3.0 to 5.4)	4.3	(3.3 to 5.4)	3.8	(3.0 to 4.9)	4.4	(3.5 to 5.7)
P for trend	<.001		<.001		<.001		<.001	

All estimates were weighted to be nationally representative.
OR adjusted for age (continues), gender, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian, others), household income, health insurance status, leisure time physical activity, education level, and smoking status

20

Table 4. Weighted Multivariable Adjusted Logistic Regression Models of US adults 20-64 Years Receiving Healthcare Providers' Advice on Lifestyle Modification, NHANES 2011-2016[a]

	Exercise			Reduce fat/calories			Control/lose weight			All of above		
Chronic condition												
Free or chronic condition	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
High blood pressure	1.9	(1.6 to	2.3)	2.1	(1.7 to	2.6)	2.0	(1.6 to	2.5)	2.3	(1.8 to	2.8)
High blood cholesterol	2.1	(1.8 to	2.4)	3.1	(2.6 to	3.7)	2.1	(1.8 to	2.5)	2.6	(2.1 to	3.2)
Osteoarthritis	3.2	(2.4 to	4.3)	4.2	(3.3 to	5.3)	3.2	(2.5 to	4.1)	4.0	(3.1 to	5.1)
Coronary heart disease	4.4	(2.9 to	6.7)	5.7	(4.0 to	8.0)	3.0	(2.3 to	4.1)	3.8	(2.8 to	5.1)
Type 2 diabetes mellitus	8.2	(5.9 to	11.4)	10.0	(7.5 to	13.4)	10.0	(7.0 to	14.1)	10.1	(7.5 to	13.7)
Age	1.0	(1.0 to	1.0)	1.0	(1.0 to	1.0)	1.0	(1.0 to	1.0)	1.0	(1.0 to	1.0)
Gender												
Men	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Women	1.7	(1.5 to	2.0)	1.4	(1.2 to	1.6)	1.7	(1.4 to	1.9)	1.6	(1.3 to	1.8)
BMI												
< 25 kg/m2	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
25 - 29.9 kg/m2	2.4	(2.0 to	2.8)	3.5	(2.8 to	4.5)	6.1	(4.3 to	8.7)	6.7	(4.3 to	10.4)
≥ 30 kg/m2	5.8	(4.9 to	6.8)	10.2	(7.8 to	13.3)	28.0	(20.0 to	39.2)	26.6	(16.1 to	44.1)
Race/ethnicity												
Non-Hispanic white	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Non-Hispanic black	1.4	(1.2 to	1.6)	1.6	(1.4 to	2.0)	1.3	(1.1 to	1.6)	1.5	(1.3 to	1.9)
Hispanic	1.7	(1.4 to	2.1)	2.0	(1.7 to	2.4)	1.6	(1.3 to	1.9)	2.0	(1.7 to	2.4)
Asian	1.9	(1.6 to	2.3)	2.1	(1.7 to	2.6)	1.5	(1.2 to	1.9)	1.7	(1.3 to	2.2)
Other	1.2	(0.9 to	1.7)	1.5	(1.1 to	2.1)	1.3	(0.9 to	1.8)	1.7	(1.2 to	2.4)
Annual household income												
<$25,000	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
$25,000-<$75,000	1.1	(0.9 to	1.3)	1.0	(0.8 to	1.2)	1.0	(0.8 to	1.2)	1.0	(0.8 to	1.2)
≥$75,000	1.3	(1.0 to	1.5)	1.1	(0.9 to	1.4)	1.2	(1.0 to	1.5)	1.2	(1.0 to	1.5)
Health insurance status												
Uninsured	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Non-private insurance	1.7	(1.4 to	2.0)	1.5	(1.2 to	1.8)	1.8	(1.5 to	2.2)	1.4	(1.1 to	1.8)
Private insurance	1.7	(1.4 to	2.1)	1.7	(1.4 to	2.0)	1.9	(1.5 to	2.3)	1.7	(1.4 to	2.1)
Leisure time physical activity												
Inactive	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Insufficient active	1.2	(1.0 to	1.4)	1.2	(1.0 to	1.5)	1.2	(1.0 to	1.4)	1.3	(1.0 to	1.6)
Sufficiently active	0.8	(0.7 to	0.9)	1.0	(0.8 to	1.3)	1.0	(0.8 to	1.2)	1.0	(0.8 to	1.3)
Education												
<High school	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
High school	1.2	(1.0 to	1.4)	0.9	(0.7 to	1.1)	1.0	(0.8 to	1.3)	1.1	(0.8 to	1.4)

21

>High school	1.4	(1.1 to 1.7)	0.9	(0.7 to 1.1)	1.2	(1.0 to 1.5)	1.2	(1.0 to 1.5)
Smoking status								
Never	1 [Reference]		1 [Reference]		1 [Reference]		1 [Reference]	
Former	1.3	(1.1 to 1.5)	1.1	(0.9 to 1.3)	1.1	(0.9 to 1.3)	1.1	(0.9 to 1.4)
Current	1.2	(1.0 to 1.4)	1.0	(0.7 to 1.2)	0.9	(0.8 to 1.1)	0.9	(0.7 to 1.2)

ᵃ All estimates were weighted to be nationally representative.