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Prevalence of Major Behavioral Risk Factors for Type 2 Diabetes

Karen R. Siegel[1], **Kai McKeever Bullard**[1], **Giuseppina Imperatore**[1], **Mohammed K. Ali**[1,2], **Ann Albright**[1], **Carla I. Mercado**[3], **Rui Li**[1], and **Edward W. Gregg**[1]

[1]Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

[2]Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA

[3]Division for Heart Disease and Stroke Prevention, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA

Abstract

OBJECTIVE—We examined the proportion of American adults without type 2 diabetes that engages in lifestyle behaviors known to reduce type 2 diabetes risk.

RESEARCH DESIGN AND METHODS—We conducted a cross-sectional analysis of 3,679 nonpregnant, nonlactating individuals aged ≥20 years without diabetes (self-reported diagnosis or glycated hemoglobin ≥6.5% [8 mmol/mol] or fasting plasma glucose ≥126 mg/dL) and who provided 2 days of reliable dietary data in the 2007–2012 National Health and Nutrition Examination Surveys (NHANES). We used the average of 2 days of dietary recall and self-reported leisure-time physical activity to assess whether participants met type 2 diabetes risk reduction goals (meeting four or more MyPlate recommendations [adequate consumption of fruits, vegetables, dairy, grains, meat, beans, and eggs]; not exceeding three maximum allowances for alcoholic beverages, added sugars, fat, and cholesterol; and meeting physical activity recommendations [≥150 min/week]).

RESULTS—Approximately 21%, 29%, and 13% of individuals met fruit, vegetable, and dairy goals, respectively. Half (51.6%) met the goal for total grains, compared with 18% for whole grains, and 54.2% met the meat/beans goal and 40.6% met the oils goal. About one-third (37.8%) met the physical activity goal, and 58.6% met the weight loss/maintenance goal. Overall, 3.1%(95% CI 2.4–4.0) of individuals met the majority of type 2 diabetes risk reduction goals. Younger age and lower educational attainment were associated with lower probability of meeting goals.

Corresponding author: Karen R. Siegel, yuo0@cdc.gov.

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CONCLUSIONS—A small proportion of U.S. adults engages in risk reduction behaviors. Research and interventions targeted at young and less-educated segments of the population may help close gaps in risk reduction behaviors.

Twelve percent of adults in the U.S. have type 2 diabetes, and over the past 25 years, prevalence has increased by 60% to 29 million individuals (1). However, there is a strong evidence base for interventions to prevent or delay type 2 diabetes among high-risk individuals. Large randomized controlled studies in China (2), Finland (3), the U.S. (4), and India (5), among others, have shown that, among individuals with prediabetes, structured behavioral approaches to modifying lifestyles (exercising more and consuming more fiber but fewer total calories, fats, and sugar-sweetened beverages) lower type 2 diabetes incidence by 30–60%. Moreover, there are long-term benefits of prevention behaviors, including greater likelihood of regression to normoglycemia (6), sustained reductions in type 2 diabetes incidence (7), and possibly fewer longterm eye complications and cardiovascular deaths (8).

Although prevention efforts for high-risk individuals (i.e., those with prediabetes) focus on structured lifestyle change programs to make and sustain these lifestyle behavior changes, efforts to reduce type 2 diabetes incidence may be optimized if population-wide changes in major dietary risk factors and physical activity levels are also achieved. As outlined in the 2017 American Diabetes Association (ADA) Standards of Care, overall healthy low-calorie eating patterns should be encouraged for type 2 diabetes risk reduction, and some evidence also shows that particular dietary components may help to lower type 2 diabetes risk (whole grains, nuts, berries, yogurt, coffee, and tea) or to raise type 2 diabetes risk (red meats and sugar-sweetened beverages) (9). Moreover, researchers have shown that dietary patterns characterized by high consumption of fruits and vegetables, whole grains, fish, and poultry and by decreased consumption of red and processed meats, high-fat dairy, processed foods (including refined grains), and sugar-sweetened beverages may reduce type 2 diabetes risk in the general population by 20% (10).

However, no analysis to date has quantified current population-wide dietary and physical activity levels in the U.S. as they relate to reducing type 2 diabetes risk. Using nationally representative data, we aimed to fill this gap by examining what proportion of American adults aged ≥20 years engages in lifestyle behaviors shown to lower type 2 diabetes risk in trials and large cohort studies. We also examined whether the proportion of individuals meeting these lifestyle goals for type 2 diabetes risk reduction varied by prediabetes status and key demographic subgroups.

RESEARCH DESIGN AND METHODS

Data Sources and Participant Selection

We used data from the National Health and Nutrition Examination Surveys (NHANES) 2007–2012 (the latest data available at time of analysis), a continuous, cross-sectional survey of the noninstitutionalized, civilian U.S. population with data released in 2-year cycles. Response rates for 2007–2012 cycles ranged from 70 to 77%. Detailed descriptions of NHANES sampling methods are provided elsewhere (11). Using the morning examination

(fasting) sample, we restricted our sample to nonpregnant, nonlactating individuals aged ≥20 years without diabetes (defined as reporting no diagnosis of diabetes by a health care provider and having glycated hemoglobin [HbA_{1c}] ≤6.5%[48mmol/mol] and fasting plasma glucose [FPG]≤126 mg/dL) and who provided two nonconsecutive days of reliable dietary data (i.e., complete dietary data as determined by NHANES). These restrictions yielded a final analytic sample of 3,679 adults representing ~48 million individuals (Supplementary Fig. 1).

Variables Measuring Type 2 Diabetes Risk Reduction Goals

We defined type 2 diabetes risk reduction lifestyle goals as meeting dietary, physical activity, and weight loss/maintenance recommendations (Table 1). We used dietary guidelines that participants in the lifestyle arm of the U.S. Diabetes Prevention Program (DPP) were encouraged to follow in order to reduce calorie and fat consumption (12). These guidelines aligned well with the 2010 U.S. Department of Agriculture's (USDA) MyPlate guidelines (previously the MyPyramid Food Guidelines) (13), which recommend adequate consumption of fruits, vegetables, dairy, grains (at least half of which are whole grains), meat, beans, and eggs and limited intake of oils, saturated fat, salt, and added sugar, and the National Cholesterol Education Program (NCEP) Step 1 diet (14), which advocates limited intake of saturated fat, total fat, and total cholesterol. Because similar recommendations for saturated fat intake were included in MyPlate (≤10% of total calories from saturated fat) and NCEP (8–10% or less of total calories), we used the MyPlate recommendation of ≤10% of total calories from saturated fat for our analysis.

Dietary Lifestyle Goal

Information about an individual's dietary intake and alcohol use came from interviewer-administered 24-h recall (the average intakes of two separate days) as well as macronutrients present in these foods, in terms of grams and kilocalories. To transform total and saturated fat into percentage of kilocalories, as characterized in MyPlate, we converted grams into kilocalories (9 kcal/g) and divided by total daily kilocalories.

To determine the amounts of the food groups (e.g., fruits, vegetables, dairy, and grains) present in reported food and beverage intake, we linked the 24-h recall data for each NHANES 2-year cycle (2007–2008, 2009–2010, and 2011–2012) to the USDA-produced Food Patterns Equivalents Databases (15), a research tool used to evaluate food and beverage intakes of Americans as compared with U.S. Dietary Guidelines.

As described above, dietary goals came from MyPlate and NCEP. The DPP intensive lifestyle intervention goals were to lose 7% of baseline weight and to increase physical activity by 150 min/week. DPP participants were encouraged to reduce calorie and fat consumption to achieve their weight loss goals and to eat a healthy dietary pattern based on My Pyramid and NCEP (12). These guidelines provide two recommendations. First, they recommend consuming adequate portions of seven items: fruits, vegetables, dairy, total grains, whole grains, meat and beans, and oils (shown in Table 3A). Second, they recommend not exceeding limited/moderate consumption of five items: added sugars, saturated fat, total fat, cholesterol, and alcohol (shown in Table 3B). These guidelines reflect

a subtle relationship with regard to type 2 diabetes risk, as outlined in the ADA Standards of Care, but include many of the dietary components that are shown to impact diabetes risk (fruits and vegetables, whole grains, yogurt, red meats, and sugar-sweetened beverages). To estimate if U.S. adults without diabetes met a reasonable level of dietary intake (and because no individuals met every dietary recommendation), we estimated proportions of the population that met at least 50% of each of the above recommendations and maximum allowances (in other words, the percentage that reported consuming any four out of the seven items recommended [recommendations] and the proportion limiting their consumption of any three of the items recommended for minimal/moderate consumption [maximum allowances]).

Physical Activity and Weight Goals

To evaluate achievement of the DPP's physical activity and weight loss/maintenance goals, we used self-reported data from the NHANES Physical Activity and Weight History modules. Leisure-time physical activity was measured in minutes of moderate-to vigorous-intensity leisure-time physical activity per week (active [>150 min/week], insufficiently active [10–150 min], and inactive [<10 min]). Achieving the weight goal was defined as either having a BMI in the normal range of 18.5 to <25 kg/m^2 or for overweight/obese individuals, answering "yes" to "have you tried to lose weight?" in the last 12 months and self-reported loss of ≥5% of body weight over the last year.

Demographic and Risk Variables

We examined proportions meeting goals by age-group, race/ethnicity, educational attainment, BMI categories, hypertension status, dyslipidemia status, history of gestational diabetes, smoking status, family history of diabetes, and prediabetes status. Hypertension was defined as systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or self-reported hypertension medication use. Dyslipidemia was defined as non-HDL cholesterol level ≥160 mg/dL or self-reported cholesterollowering medication use. Prediabetes was defined as no self-reported diabetes and 5.7%≤ HbA_{1c} ≤6.4% (39≤ HbA_{1c} ≤46 mmol/mol) or 100≤ FPG <126 mg/dL.

Statistical Analysis

We used statistical analysis software (SAS version 9.4; SAS Institute) and SAS-callable SUDAAN (version 10.0; RTI International, Research Triangle Park, NC) to account for the NHANES complex sampling design and weights.

Using weighted proportions and means with SE, we estimated the distributions of characteristics of the population overall and by prediabetes status. We calculated average daily intakes (geometric mean and SE) of food groups and nutrients as well as the percentage (and SE) of people meeting individual goals and combined lifestyle goals, overall and by prediabetes status. We used multivariable logistic regression to predict the probability of meeting ≥50% of dietary and physical activity lifestyle goals across different at-risk subgroups. To do this, we fit a model whereby the dependent variable was defined as meeting type 2 diabetes risk reduction goals (at least four out of the seven MyPlate recommendations [≥50%] shown in Table 3A, at least three out of five maximum allowances

[≥50%] shown in Table 3B, and meeting the physical activity goal of 150 min of moderate-intensity leisure-time physical activity per week), and the independent variables were the demographic and at-risk subgroups noted above. We also fit individual models for each of the goal "categories": MyPlate recommendations, maximum allowances, and physical activity. Individuals with missing data (<10% of the sample population) were excluded from the models. *P* values were calculated using χ^2 tests; *P* values <0.05 were considered statistically significant. We did not adjust for multiple testing as this could lead to misinterpretation of the data (16).

RESULTS

Almost half (47.7%) of the population was male and the mean age was 46.3 years (Table 2). Among U.S. adults with prediabetes, a higher percentage were males, were older, had less than a college education, were overweight/obese ($P < 0.001$ for all), were non-Hispanic black ($P = 0.01$), and were smokers than in those without prediabetes. On average, U.S. adults without diabetes consumed less than the recommended amounts of fruits, vegetables, dairy, whole grains, eggs, and healthy oils; exceeded maximum allowances for total fats; and reached maximum allowances for saturated fats, added sugars, and cholesterol (Supplementary Table 1).

Approximately 21%, 29%, and 13% of adults without diabetes met fruit, vegetable, and dairy goals, respectively (Table 3A). Half met the goal for total grains, whereas only 18% met the goal for healthier whole grains. About half of people without diabetes met the meat and beans goal and 40% met the oils goal. Slightly more than one-third met the physical activity goal; fewer people with prediabetes (31.7%), compared with those without prediabetes (42.3%), met the goal ($P < 0.001$). The majority of people without diabetes (58.6%) met the weight loss/maintenance goal, and about half of people with prediabetes (49.9%) met the goal compared with nearly two-thirds without prediabetes (63.8%) ($P < 0.001$). A subanalysis showed that only 6.5% of overweight/obese adults without diabetes met the weight loss/maintenance goal, and this did not vary by prediabetes status ($P = 0.74$).

Across the population, relatively small percentages of adults without diabetes kept their consumption under maximum allowances for added sugars (24.1%), saturated fat (42.7%), and total fat (33.7%) (Table 3B). The majority (65.1%) did not exceed cholesterol limits; although this varied for people with and without prediabetes (62.2% vs. 67.3%, $P = 0.02$). More than 90% were within daily limits for alcohol intake.

Overall, 3.1% (95% CI 2.4–4.0) of U.S. adults without diabetes met the majority of type 2 diabetes risk reduction goals (Fig. 1 and Supplementary Table 2). Compared with those aged 45–64 years, people aged 20–44 years were less likely to meet goals (prevalence ratio 0.44 [95% CI 0.28–0.70], $P = 0.002$). People with less than a high school education were less likely to meet goals than those with at least some college (prevalence ratio 0.27 [0.14–0.53], $P < 0.001$). We found no statistically significant variation in achievement of goals by sex, race/ethnicity, obesity status, hypertension, dyslipidemia, history of gestational diabetes, family history of diabetes, or smoking status. Prediabetes status (either known or unknown)

was also not statistically significantly associated with meeting lifestyle goals for reducing type 2 diabetes risk.

Supplementary Fig. 2 shows the adjusted prevalence of meeting each of the components of the type 2 diabetes risk reduction goals (MyPlate recommendations, maximum allowances, and physical activity). Overall, 18.1% (95% CI 16.4–19.9) of U.S. adults without diabetes met the MyPlate recommendations, 40.6% (95% CI 38.5–42.8) met the maximum allowances, 6.1% (95% CI 5.3–7.1) met a combination of the MyPlate recommendations and maximum allowances, and 37% (95% CI 34.5–39.6) met the physical activity goal.

CONCLUSIONS

Despite strong evidence that type 2 diabetes can be prevented or delayed through healthy diet and adequate physical activity, only 3.1% of American adults without diabetes met the majority of the type 2 diabetes risk reduction lifestyle goals in 2007–2012. Being younger and less educated were associated with having a 56–73% lower probability of meeting the lifestyle goals. Interestingly, prediabetes status (and whether or not a person was aware of their status) was not associated with meeting lifestyle goals for reducing type 2 diabetes risk. The finding that the majority of Americans do not meet most of the individual diet goals is particularly noteworthy in light of findings from previous type 2 diabetes prevention trials, such as the Finnish Diabetes Prevention Study, which showed that an increased number of type 2 diabetes prevention goals met is correlated with decreased type 2 diabetes incidence (17). Our results suggest that the majority of the U.S. population without diabetes could substantially reduce their risk for type 2 diabetes.

Our findings are consistent with previous literature in the U.S. highlighting the suboptimal diet quality in the country, that most Americans do not consume healthy foods (18), and that the leading causes of death and disability are diet related (19). Another study used NHANES data from 2003 to 2006 to estimate the prevalence of four healthy behaviors (being sufficiently active, eating a healthy diet as defined by the Healthy Eating Index, being a nonsmoker, and having a recommended body fat percentage) found that only 2.7% of U.S. adults achieved all four goals (20). The low percentages of individuals engaging in behaviors that could help reduce type 2 diabetes risk in this and the current study (which excluded smoking status as a risk factor due to our interest in primary DPP intervention components) represent a large potential for improvement and type 2 diabetes risk reduction at the population level. For example, lifestyle interventions among individuals at high risk of developing type 2 diabetes patterned after the DPP (in which trained counselors coach consumers on healthier eating habits, increased physical activity, and stress reduction) have been effective in diverse settings, including communities, workplaces, clinics, large health systems, and through online media (21–23).

Our study population included individuals without diabetes aged ≥20 years across a wide spectrum of type 2 diabetes risk, from people with normal blood glucose values to those with prediabetes. Although lower-risk people may not currently seem to be an urgent priority for primary prevention, without the benefit of public health interventions to increase healthy lifestyle behaviors, they may move into higher-risk categories in >10–20 years. At

the same time, people with prediabetes may progress to type 2 diabetes at a faster rate, and thus there is a need for primary prevention efforts to specifically address these higher-risk individuals with more intensive lifestyle interventions (24). The National DPP provides a framework and infrastructure for programs that target the high-risk population, which has led to commercial and public insurers covering intensive lifestyle interventions. In 2018, the Centers for Medicare and Medicaid Services began to cover Centers for Disease Control and Prevention–recognized DPP-like lifestyle change programs (25). Our finding that U.S. adults with prediabetes were no more likely than people with lower risk for type 2 diabetes to meet risk reduction goals suggests that nationwide efforts to identify people with prediabetes and facilitate engagement to improve utilization of the National DPP are important.

For lower-risk individuals, recent data show that type 2 diabetes risk reduction behaviors are associated with small, but meaningful, reductions in metabolic parameters, but there is still much work to be done to help prioritize health promotion approaches to benefit this large population group at reasonable cost (26). The restructuring of food policies and built environments may help to facilitate healthier population-wide behaviors. Ecological evidence shows that higher availability of healthy foods, such as fruits and vegetables, is associated with lower type 2 diabetes prevalence, whereas higher availability of sugar/sweeteners and animal fats is associated with higher type 2 diabetes prevalence (27). Other analyses suggest that the U.S. food supply and nutritional needs are not aligned; our food supply is abundant in foods recommended for limited intake but inadequate in foods recommended for maximum intake (28). Recent evidence suggests that soda taxes may play a role in reducing consumption of sugar-sweetened beverages, especially among lower-income individuals (29). Lastly, community-level access to healthy foods may play a role in certain subpopulations falling short of recommendations.

Our finding that individuals without prediabetes were significantly more likely than individuals with prediabetes to meet the physical activity and weight loss/maintenance goals (but not the dietary goals) may be helpful for tailoring population-wide type 2 diabetes prevention efforts. Specifically focusing on a few key dietary goals that have a relatively low level of population adherence but a potentially large health impact may be an important avenue to consider and study. Examples of such dietary goals include increasing fruit and vegetable and whole grain intake (while making efforts to keep total daily caloric intake within recommended amounts) and reducing intake of added sugars, particularly in the form of sugar-sweetened beverages.

A major strength of our analysis is that it was grounded in type 2 diabetes prevention lifestyle goals that have been found to help prevent or delay the development of type 2 diabetes among those at high risk (12). The dietary recommendations come from the lifestyle arm of the DPP, which was based on the USDA’s My-Pyramid guidelines and the NCEP Step 1 diet (30). Population-based observational and longitudinal cohort studies bolster links between type 2 diabetes and specific dietary components: higher fruit and vegetable intake has been associated with a 7% lower type 2 diabetes risk (31), higher intake of whole grains can reduce type 2 diabetes risk by 30% in nonobese individuals (by 17% in obese individuals) (32), regular consumption of full- and low-fat dairy is associated with a 4–14% reduction in type 2 diabetes risk (33) (although the role of dairy products in type 2

diabetes prevention is currently being debated) (34), and higher consumption of sugar-sweetened beverages (one of the primary sources of added sugars in the U.S.) has been associated with up to 18% greater incidence of type 2 diabetes per serving/day (35). The physical activity goal of 150 min of moderate/vigorous leisure-time physical activity was selected to approximate at least a 700 kcal/week expenditure from physical activities and was adopted because it was determined to be achievable and likely to be beneficial in preventing type 2 diabetes based on previous studies. For example, in a study of 6,000 men followed for 14 years, each 500 kcal/week increase in physical activity reduced the age-adjusted risk of type 2 diabetes by 6% (36). Behavioral weight loss studies with participants with diabetes (37) and without diabetes (38) have often used a 1,000 kcal/week activity goal. It is also worth noting here that population strategies that address diet and physical activity would have health benefits for other diseases such as cancer and heart disease.

Our analysis does have some limitations. First, we did not calculate usual dietary intakes for our dietary intake variables. Usual intakes, the long-run average daily intake of a nutrient or food that can be calculated using algorithms such as those created by the National Cancer Institute, can be useful for taking into account fluctuations in the intakes of foods that may be consumed irregularly or at least on a nondaily basis. We instead calculated average values based on 2 days of 24-h recalls. Second, we were limited by the data available; NHANES does not include variables on measured weight change or physical activity (we used self-reported measures for both). Third, underreporting of consumption of certain foods high in sugar, fat, salt, or energy may occur across the population but may also be more common among certain subgroups, such as people who are obese (39). Fourth, our analysis is crosssectional, yielding no evidence on whether meeting diabetes risk reduction goals leads to reduced diabetes incidence. Fifth, although we focused on MyPlate, other dietary patterns may also reduce type 2 diabetes risk. For example, the Prevención con Dieta Mediterránea (PREDIMED) trial has shown that the Mediterranean diet might also prove valuable in terms of type 2 diabetes and cardiometabolic disease prevention (40). Additionally, there may be some components of MyPlate (dairy products, for example) for which our understanding of an association between intake and type 2 diabetes prevention is still not entirely unequivocal. In the case of dairy products, potential mechanisms are as yet unknown; the association may or may not be causal and may apply only to certain dairy products, such as fermented dairy. Future analyses may help to fill these gaps. Finally, our analysis did not account for caloric intake, a contributor to weight gain; people who meet other dietary recommendations may still be consuming excess calories.

To our knowledge, this is the most comprehensive nationally representative data to estimate the proportion of the population without diabetes that engages in recommended type 2 diabetes risk reduction behaviors. Despite the high lifetime risk of type 2 diabetes and the current magnitude of the type 2 diabetes burden nationally, there has been very little focus to date on detailed dietary recommendations for reducing type 2 diabetes risk or on efforts to closely monitor dietary risk factors specific to type 2 diabetes. This paper has the potential to set a baseline for future surveillance efforts in this area. Our results show that only 3.1% of U.S. adults engage in a majority of recommended type 2 diabetes risk reduction behaviors, suggesting a vast opportunity to reduce type 2 diabetes risk among people with prediabetes as well as the general population in the country through improvement of these modifiable

dietary and physical activity behaviors. Combining evidence-based strategies for reducing type 2 diabetes across the whole population with evidence-based structured lifestyle programs for those with prediabetes may help address the current and future burdens of type 2 diabetes in the U.S.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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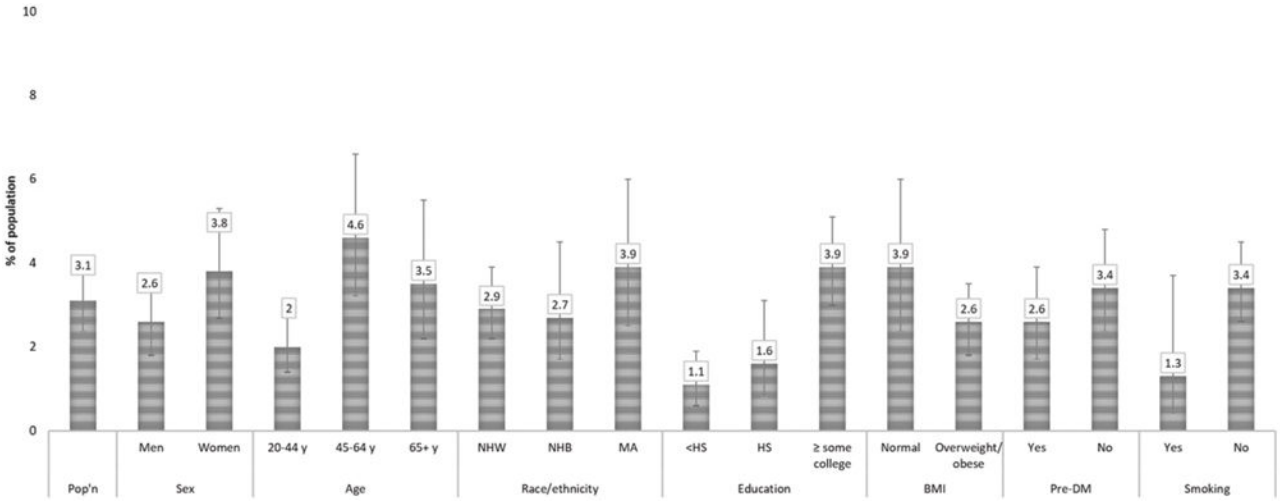

Figure 1.

Adjusted prevalence of meeting the majority of type 2 diabetes prevention goals. The dependent variable was defined as meeting the majority of diabetes prevention goals: at least four MyPlate recommendations, at least three maximum allowances, and meeting the physical activity goal of 150 min of moderate-intensity leisure-time physical activity per week. The reference category was meeting fewer than four MyPlate recommendations, fewer than three maximum allowances, and not meeting the physical activity goal of 150 min of moderate-intensity leisure-time physical activity per week. “Other” race/ethnicity was also included in the analysis but results are not shown here. BMI was categorized as underweight (not shown, ≤18.5 kg/m^2), normal (>18.5 to <25 kg/m^2), or overweight/obese (≥25 kg/m^2). Prediabetes was categorized as yes (5.7%≤ HbA_{1c} ≤6.4% or 100≤ FPG <126mg/dL)or no (HbA_{1c} <5.7% and FPG <126mg/dL). HS, high school; MA, Mexican American; NHB, non-Hispanic black; NHW, non-Hispanic white; Pop’n, population; pre-DM, prediabetes.

Table 1

Lifestyle goals for diabetes prevention by age and sex

	Sex/age-group[1]					
	Women			Men		
Goal	**20–30 years**	**31–50 years**	**51+years**	**20–30 years**	**31–50 years**	**51+ years**
MyPlate daily recommendations 2015						
Fruits (cup-equivalents)[2]	2.0	1.5	1.5	2.0	2.0	2.0
Vegetables (cup-equivalents)	2.5	2.5	2.0	3.0	3.0	2.5
Dairy (cup-equivalents)	3.0	3.0	3.0	3.0	3.0	3.0
Total grains (ounce-equivalents)[3]	6.0	6.0	5.0	8.0	7.0	6.0
Whole grains (ounce-equivalents)	3.0	3.0	2.5	4.0	3.5	3.0
Meat and beans (ounce-equivalents)[4]	5.5	5.0	5.0	6.5	6.0	5.5
Oils (tsp)	6.0	5.0	5.0	7.0	6.0	6.0
Saturated fat	No >10% of calories from saturated fat					
Added sugars	No >10% of calories from added sugars					
Limited alcohol use	No >2 drinks per day			No >3 drinks per day		
NCEP Step 1 diet						
Saturated fat	Saturated fat intake of 8–10% or less of total calories					
Total fat	30% or less of calories from total fat					
Cholesterol	<300 mg of cholesterol per day					
Weight loss or maintenance	Normal body weight or lose 5–10% of initial weight					
Leisure-time physical activity	Moderate intensity for ≥150 min/week					

[1] MyPlate recommendations depend on appropriate level of energy, and energy needs vary by activity level, sex, and age. For this analysis, <30 min/day of moderate physical activity, beyond normal activities, was assumed.

[2] MyPlate recommendations for fruits, vegetables, and dairy are expressed in cup-equivalents. A cup-equivalent is equal to 1 cup of fruit or fruit juice, 1 cup of raw or cooked vegetables or vegetable juice, and 1 cup of milk.

[3] MyPlate recommendations for grains and meat and beans are expressed in ounce-equivalents. An ounce-equivalent of grains is equal to one slice of bread and an ounce-equivalent of meat and beans is equal to 1 ounce of cooked meat, poultry, or fish.

[4] Includes meat, poultry, seafood, beans, eggs, soy, nuts, and seeds.

Table 2

Characteristics (% [SE]) of U.S. adults without diabetes aged 20+ years, overall and by prediabetes status, NHANES 2007–2012

Goal	Total population	Prediabetes	No prediabetes	*P* value
n	3,679	1,985	1,694	
Sex (%)				<0.001
Males	47.7 (0.8)	51.2 (1.5)	45.2 (0.9)	
Age (%)				<0.001
20–44 years	48.6 (1.6)	30.3 (1.6)	61.8 (1.9)	
45–64 years	36.0 (1.4)	44.8 (1.8)	29.6 (1.7)	
65+ years	15.5 (0.6)	24.9 (1.1)	8.6 (0.7)	
Mean age (years)	46.3 (0.5)	52.8 (0.6)	41.5 (0.5)	
Race/ethnicity (%)				0.01
Non-Hispanic white	71.3 (2.2)	71.3 (2.5)	71.2 (2.2)	
Non-Hispanic black	9.5 (1.0)	10.8 (1.2)	8.6 (0.9)	
Mexican American	12.8 (1.6)	12.6 (1.6)	13.0 (1.7)	
Educational attainment (%)				<0.001
Less than high school	15.4 (1.2)	20.0 (1.6)	12.0 (1.2)	
High school	21.0 (1.2)	24.1 (1.8)	18.7 (1.4)	
At least some college	63.7 (1.6)	55.9 (2.4)	69.3 (1.8)	
BMI (%)				<0.001
Underweight	1.7 (0.3)	0.6 (0.2)	2.4 (0.5)	
Normal weight	31.9 (1.2)	23.3 (1.7)	38.1 (1.6)	
Overweight	34.5 (1.1)	33.7 (1.6)	35.1 (1.5)	
Obese	32.0 (1.1)	42.4 (1.5)	24.4 (1.5)	
Smoking status (% not smoking)	81.2 (1.0)	78.3 (1.5)	83.2 (1.3)	0.01

BMI index was categorized as underweight (≤18.5 kg/m^2), normal (>18.5 to <25 kg/m^2), overweight (25 to <30 kg/m^2), or overweight/obese (≥30 kg/m^2). Prediabetes was categorized as yes (5.7%≤ HbA_{1c} ≤6.4% or 100≤ FPG <126 mg/dL) or no (HbA_{1c} <5.7% and FPG <126 mg/dL).

Table 3

Percentages of U.S. adults without diabetes meeting goals of recommended MyPlate food groups and physical activity (*A*) and not exceeding maximum allowances for solid fats, alcoholic beverages, added sugars, total fat, and cholesterol (*B*), 2007–2012, overall and by prediabetes status

(*A*)	Total population[1]	Prediabetes	No prediabetes	*P* value
n	3,679	1,985	1,694	
Diet (recommendations)				
Fruits	21.6 (1.05)	21.4 (1.49)	21.8 (1.21)	0.83
Vegetables[2]	28.7 (1.02)	29.1 (1.84)	28.3 (1.58)	0.78
Dairy	13.3 (0.73)	12.2 (0.89)	14.0 (1.09)	0.20
Total grains	51.6 (1.12)	51.5 (1.68)	51.6 (1.36)	0.97
Whole grains	18.4 (0.85)	18.1 (1.22)	18.6 (1.13)	0.78
Meat and beans[2]	54.2 (1.29)	55.1 (1.88)	53.6 (1.58)	0.53
Oils	40.6 (1.14)	39.6 (1.68)	41.3 (1.26)	0.33
Number of MyPlate recommendations met				
≥1	91.5 (0.65)	92.5 (0.79)	90.8 (0.90)	0.15
≥2	69.4 (1.14)	69.4 (1.86)	69.5 (1.17)	0.94
≥3	42.1 (1.11)	40.9 (1.91)	42.9 (1.46)	0.40
≥4 (cutoff for meeting goal)	18.6 (0.90)	17.8 (1.27)	19.1 (1.48)	0.55
≥5	5.9 (0.50)	5.9 (1.05)	5.8 (0.67)	0.98
≥6	0.8 (0.20)	0.6 (0.23)	1.0 (0.32)	0.34
Leisure-time physical activity	37.8 (1.33)	31.7 (1.79)	42.3 (1.66)	<0.001
Weight loss or maintenance	58.6 (1.59)	49.9 (2.90)	63.8 (1.89)	<0.001
(*B*)				
Diet (maximum allowances)				
Added sugars	24.1 (1.56)	25.0 (2.13)	23.4 (1.67)	0.40
Saturated fat	42.7 (1.31)	41.0 (1.85)	43.9 (1.56)	0.19
Total fat	33.7 (0.85)	32.6 (1.38)	34.5 (1.11)	0.31
Cholesterol	65.1 (1.03)	62.2 (1.23)	67.3 (1.62)	0.02
Alcohol use	91.0 (0.70)	92.0 (0.91)	90.2 (0.94)	0.15
Number of maximum allowances met				
≥1	98.5 (0.26)	98.1 (0.40)	98.7 (0.34)	0.23

(A)	Total population[1]	Prediabetes	No prediabetes	P value
≥2	75.2 (0.93)	73.3 (1.42)	76.6 (1.34)	0.13
≥3 (cutoff for meeting goal)	40.6 (1.06)	39.5 (1.41)	41.4 (1.39)	0.32
≥4	19.7 (0.94)	18.5 (1.16)	20.6 (1.35)	0.24
5	0.3 (0.09)	0.5 (0.17)	0.2 (0.10)	0.28

Data are percentage (%) and SE. Sex/age-specific recommendations were applied prior to estimating percentages for collapsed groups.

[1]MyPlate recommendations depend on appropriate level of energy, and energy needs vary by activity level, sex, and age.

[2]Following MyPlate, legumes were first allocated to the meat and beans group; any amount remaining after the meat and beans group recommendation was met counted toward the total vegetables and legumes groups.