Control of Cardiovascular Risk Factors Among US Adults With Type 2 Diabetes With and Without Cardiovascular Disease

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Cardiovascular disease (CVD) remains leading cause of death among adults with type 2 diabetes (T2DM). There is a lack of recent national data on attainment of single and multiple CVD risk factor targets among adults with T2DM with and without CVD. We identified 1179 T2DM adults (projected to 19.7 million in the US population) aged ≥18 years from the US National Health and Nutrition Examination Survey (NHANES) 2013-2016 and examined those at target for hemoglobin A1c (HbA1c <7.0%, <8.0% if CVD), blood pressure (BP <130/80 mm Hg), low-density lipoprotein cholesterol (LDL-C <100 mg/dL non-CVD and LDL-C <70 mg/dL CVD), nonsmoking status, and body mass index (BMI <30 kg/m^{2}and BMI <25 kg/m^2) individually and as a composite in those with versus without prior CVD. Overall, around half of T2DM adults were at target control of HbA1c (55.8%), BP (51.3%), LDL-C (49.3%), with more being nonsmokers (84.3%). The proportion at target for these factors was slightly higher among those with CVD except for LDL-C. BMI was least frequently at target control (9.1% for BMI <25 kg/m^2) compared to other risk factors. Moreover, only 17.3% of T2DM patients reached composite target control of HbA1c, BP and LDL-C, with 16.0% reaching target control when nonsmoking status was included and <10% if we included BMI targets. The proportion of patients at composite control was lower in those with versus without with prior CVD. Less than one-fifth adults with T2DM are at composite CVD risk factor control for HbA1c, BP, LDL-C, and nonsmoking status. **(Am J Cardiol 2019;124:522−527)**

There are limited data on recent individual and composite cardiovascular disease (CVD) risk factor control in type 2 diabetes (T2DM) patients. Several studies have shown the association between sufficient CVD risk control and improved CVD outcomes, thus it is important to understand the prevalence of CVD risk factors in the T2DM population.[1−5] Our prior study of US adults showed those with versus without known CVD to have similar individual and composite risk factor control; however, given newer targets of risk factor management, more recent data are needed to guide healthcare providers and payers where gaps in treatment may still exist.[6] The purpose of this study is to examine the proportion at individual and composite CVD risk factor control among T2DM adults with and without prior CVD over recent years in the US population.

Methods

We used the cross-sectional National Health and Nutrition Examination Survey (NHANES) 2013-2016 to examine the prevalence of risk factor control among adults with T2DM. NHANES is a multistage cross-sectional survey administered by the Centers for Disease Control and Prevention, containing demographic information, medical history, and medical examination data from a US national population-based sample. The methodology of NHANES data collection has been described elsewhere.[7] T2DM status was defined as a patient with any of the following criteria: (1) fasting glucose ≥126 mg/dL after 12 hours of fasting, (2) nonfasting glucose ≥200 mg/dL, (3) use of oral antidiabetes medications or insulin, or (4) being told by a doctor that they had diabetes, with diagnosis age of ≥30 years, which has been previously used as a criterion for identifying those with T2DM.[6] Our sample included those aged ≥18 years with T2DM, providing a final sample size of 1179 (projected to 19.7 million US population).

Examination, laboratory test results, and medical history information were used from the NHANES data. Blood pressure (BP) measurements were taken using a mercury sphygmomanometer and averaged from 4 measurements. Hemoglobin A1c (HbA1c) was measured using high-performance liquid chromatography. Serum low-density lipoprotein cholesterol (LDL-C) was derived from participants examined in the morning session only (with applicable morning fasting weighting to the general US population provided), where examinees were fasting for 8.5 hours or more. Total cholesterol and triglycerides (TG) were assayed using enzymatic reactions on a Roche/Hitachi Modular P Chemistry Analyzer. High-density lipoprotein cholesterol (HDL-C) was analyzed through a modified traditional multistep precipitation reaction. LDL-C was calculated from measured values of total cholesterol, triglycerides, and HDL-C based on the Friedewald calculation: [LDL-C] = [total cholesterol] − [HDL-C] − [TG/5] if TG ≤400 mg/dL. HDL-C was measured through an

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immunoassay technique. Chronic kidney disease (CKD) was defined as an estimated glomerular filtration rate <60 mL/min according to Modification of Diet in Renal Disease Study (MDRD) equation. Specimen and data collection details were described in the Laboratory Procedures Manual.[8] Body mass index (BMI) was calculated from participant height and weight, which were measured by health technicians. Height was measured using a stadiometer platform and weight was measured using a digital weight scale. Smoking status was self-reported. Nonsmoking status was defined as never having smoked or quit >12 months prior. Previous smoker status was defined as quitting smoking ≤12 months prior. Current smoker status was defined as someone who currently smokes. We further stratified our sample by CVD status. CVD was defined as self-reported presence of coronary heart disease (CHD), stroke, heart failure, heart attack, or angina.

The American Diabetes Association guidelines[9,10] was the basis for our recommended or normal levels for specific risk factors: (1) LDL-C <100 mg/dL in those without CVD or <70 mg/dL in those with CVD, (2) HbA1c level of <7% in those without CVD or <8% in those with CVD (3) BP <130/80 mm Hg, and (4) nonsmoking status. Further, criteria for obesity and overweight have been classified as BMI <30 kg/m^2 or <25 kg/m^2, respectively, and these guidelines have been set as target levels to reduce CVD risk by the AHA.[11,12] We also defined composite risk factor control for (1) HbA1c, BP, and LDL-C; (2) HbA1c, BP, LDL-C, and nonsmoking status, (3) HbA1c, BP, LDL-C, nonsmoking status, and BMI <30 kg/m^2, and (4) HbA1c, BP, LDL-C, nonsmoking status, and BMI <25 kg/m^2.

We included NHANES data from 2013 to 2016 and used corresponding weighted variables to appropriately represent the US noninstitutionalized civilian resident population. Demographic information was compared by CVD status among the T2DM population using a survey *t* test or Chi-square test for continuous and categorical variables, respectively. Mean levels of risk factors, including HbA1c, systolic blood pressure (SBP), diastolic blood pressure (DBP), LDL-C, and BMI, were examined over the 4-year period, along with the prevalence of being at goal for the risk factors. We also examined the proportion of subjects at simultaneous control for HbA1c, BP, and LDL-C; HbA1c; HbA1c, BP, LDL-C, and nonsmoking status; HbA1c, BP, LDL-C, nonsmoking status, and BMI <30 kg/m^2; and HbA1c, BP, LDL-C, nonsmoking status, and BMI <25 kg/m^2. For analysis of patients at goal for LDL-C and for patients at goal for composite risk factors, a subsample of 552 morning fasting sample patients was analyzed, with 143 having prevalent CVD (projected to 5.5 million US adults, 24.9%). Data analyses utilized SAS (*version 9.4; SAS Institute, Cary, NC*) for computation of weighted estimates for US population.

Results

A total of 1179 T2DM patients (projected to 19.7 million) were identified from NHANES 2013 to 2016, of which 289 (projected to 4.7 million US adults, 23.7%) were defined as having prevalent CVD. Our sample had a mean age of 60.0 years, and was mostly male and non-Hispanic White. Overall, our sample population was on average obese (mean BMI of 33.2 kg/m^2), with mean TG of 201.1 mg/dL and HbA1c of 7.4%. 84.3% were nonsmokers and mean duration of diabetes averaged 11.4 years. 95.9% and 87.7% were currently taking BP- or lipid-lowering medications, respectively, with 18.2% having chronic kidney disease (CKD) (Table 1). T2DM adults with CVD were older (66.0 vs 58.1 years, p <0.0001) and mostly male, with greater waist circumference (115.5 cm vs 111.3 cm, p = 0.0336), lower LDL-C (91.9 mg/dL vs 99.8 mg/dL, p = 0.0083), more prevalent CKD (29.2% vs 14.8%, p <0.0001), and longer duration of diabetes (14.2 vs 10.4 years, p = 0.0037) compared to those without CVD. These results are summarized in Table 1.

Table 2 and Figure 1 provide the proportion of T2DM patients at goal for individual risk factors, including HbA1c, BP, LDL-C, and BMI. The proportion of patients at target control was lower for those with versus without CVD for LDL-C (26.4% vs 56.8%, p <0.0001), and (but not significantly) for BMI <30 kg/m^2 and BMI <25 kg/m^2. Those with compared to without prevalent CVD were more likely at target for HbA1c (73.3% vs 50.4%, p = 0.0001).

The proportions of patients at target control for composite risk factors are displayed in Table 3 and Figure 2. Overall, 17.3% of the T2DM population were at composite risk factor control of HbA1c, BP and LDL-C, 16.0% were at target if nonsmoking status was considered, and only 7.9% were at target if BMI < 30kg/m^2 was also included. This proportion was at only 2.7% if BMI was restricted to < 25kg/m^2. When stratified by CVD status, a lower proportion at target composite control was seen among those with compared to without CVD for those at target for HbA1c, BP, LDL-C, and nonsmoking status (6.8% vs 19.0%, p = 0.0057), and at target for HbA1c, BP, LDL-C, nonsmoking status, and BMI < 30 kg/m^2 (2.7% vs 9.6%, p = 0.0254). No patients with T2DM and CVD were at goal for HbA1c, BP, LDL-C, nonsmoking status, and BMI <25 kg/m^2, while 3.6% of patients without CVD were at goal for this target (data not shown in table).

We further stratified individual and composite risk factor control and medication use by CVD status and by sex. We found that among those without CVD, females were more likely than males to be at target control for HbA1c (55.1% vs 45.9%, p = 0.0489), while males were more likely than females to be at target control for LDL-C (62.0% vs 51.9%, p = 0.0454) and BMI <30 kg/m^2 (44.6% vs 28.4%, p <0.0001). Blood pressure control and nonsmoking status did not differ by sex. Males, with and without CVD, were also significantly more likely than females to take lipid-lowering medications. There were no significant differences between sex in antidiabetic or blood pressure-lowering medication use.

Discussion

Our investigation of recent US adults shows almost one-fourth of T2DM patients have known CVD, and many remain inadequately controlled for individual and composite CVD risk factors. With CVD as the leading cause of death among the T2DM population, CVD prevention focusing on control of composite CVD risk factors is particularly important. Although there have been mixed findings from several trials regarding intensive control of BP and HbA1c

Table 1
Demographic characteristics of participants with T2DM stratified by CVD status, NHANES 2013-2016

Variable	Total (n = 1179, N = 19.7M)	Cardiovascular disease		p Value
		No (n = 890, N = 15.0M)	Yes (n = 289, N = 4.7M)	
Age (years)	60.0 ± 0.4	58.1 ± 0.5	66.0 ± 0.7	<0.0001
Male	603 (10.3M, 52.1%)	440 (7.6M, 50.6%)	163 (2.7M, 56.9%)	0.1748
Female	576 (9.4M, 47.9%)	450 (7.4M, 49.4%)	126 (2.0M, 43.1%)	
Non-Hispanic White	375 (12.4M, 62.7%)	255 (9.1M, 60.5%)	120 (3.3M, 70.2%)	0.0681
Mexican-American	228 (2.0M, 10.0%)	187 (1.7M, 11.1%)	41 (0.3M, 6.2%)	
Non-Hispanic Black	275 (2.7M, 13.5%)	213 (2.1M, 14.0%)	62 (0.6M, 11.9%)	
Non-Hispanic Asian	133 (1.3M, 6.4%)	109 (1.0M, 6.9%)	24 (0.2M, 4.8%)	
Other Hispanic	146 (1.0M, 5.4%)	107 (0.8M, 5.5%)	39 (0.2M, 4.9%)	
Other race	22 (0.4M, 2.0%)	19 (0.3M, 2.0%)	3 (0.1M, 2.0%)	
BMI (kg/m^2)	33.2 ± 0.3	32.9 ± 0.3	34.3 ± 0.7	0.0825
Waist circumference (cm)	112.3 ± 0.6	111.3 ± 0.7	115.5 ± 1.6	0.0336
SBP (mm Hg)	139.9 ± 0.9	129.9 ± 1.0	129.0 ± 1.4	0.5802
DBP (mm Hg)	68.3 ± 0.4	69.9 ± 0.4	63.2 ± 1.1	<0.0001
HbA1c (%)	7.4 ± 0.1	7.4 ± 0.1	7.4 ± 0.2	0.8798
Triglycerides (mg/dL)	201.1 ± 9.2	201.5 ± 11.1	199.6 ± 11.0	0.8968
*LDL-C (mg/dL)	97.8 ± 1.6	99.8 ± 1.9	91.9 ± 2.4	0.0083
HDL-C (mg/dL)	47.3 ± 0.7	47.8 ± 0.7	45.7 ± 1.3	0.1472
Smoking Status				0.4851
Never	982 (16.7M, 84.3%)	739 (12.7M, 83.9%)	243 (4.0M, 85.6%)	
†Former	28 (0.4M, 2.1%)	23 (0.4M, 2.5%)	5 (0.05M, 1.0%)	
Current	169 (2.7M, 13.6%)	128 (2.1M, 13.6%)	41 (0.6M, 13.4%)	
‡Physical activity				0.0576
None	433 (7.1M, 36.2%)	308 (5.1M, 34.2%)	125 (2.0M, 42.8%)	
Moderate	528 (8.7M, 43.9%)	415 (7.0M, 46.3%)	113 (1.7M, 35.9%)	
Intense	218 (3.9M, 19.9%)	167 (2.9M, 19.5%)	51 (1.0M, 21.3%)	
Chronic kidney disease	220 (3.6M, 18.2%)	124 (2.2M, 14.8%)	96 (1.4M, 29.2%)	<0.0001
Duration of diabetes (years)	11.4 ± 0.4 (n=1032)	10.4 ± 0.5 (n=770)	14.2 ± 1.0 (n = 262)	0.0037
Taking prescription for hypertension	798 (13.0M, 95.9%)	574 (9.4M, 94.7%)	224 (3.6M, 99.0%)	0.0020
Taking prescription for high cholesterol	687 (11.9M, 87.7%)	481 (8.5M, 86.4%)	206 (3.4M, 91.2%)	0.1302
Has health insurance	1045 (18.0M, 91.5%)	778 (13.7M, 91.0%)	267 (4.3M, 93.2%)	0.3087

Numbers were displayed as weighted mean ± SE or weighted frequency.

Abbreviations: BMI = body mass index, SBP = systolic blood pressure, DBP = diastolic blood pressure, HbA1c = glycated hemoglobin, LDL-C = low-density lipoprotein cholesterol, HDL-C = high-density lipoprotein cholesterol

* LDL-C values were only available among n = 552 (N = 22.2M) subjects who were randomly assigned to a morning fasting session. Of the 552, n = 409 (N = 16.7M) had no CVD and n = 143 (N = 5.5M) had CVD. A different weighted procedure was applied for population estimation.Information regarding hypertension medication was only available among n = 828 (N = 13.5M) subjects, 228 (3.7M) and 600 (9.9M) among those with and without prior CVD, respectively.Information regarding cholesterol medication was only available among n = 792 (N = 13.6M) subjects, 223 (3.8M) and 569 (9.8M) among those with and without prior CVD, respectively.Information regarding duration of diabetes was only available among n = 1032 (N = 17.4M) subjects, 262 (4.3M) and 770 (13.1M) among those with and without prior CVD, respectively.

† Former smoker was defined as quit smoking for at least 12 months.

‡ Physical activity definitionsNo exercise: 0 minutes daily vigorous-/moderate- intensity work, 0 minutes daily vigorous/moderate recreational activities, and 0 minutes daily walking/bicyclingModerate exercise: less than 75 minutes daily vigorous-intensity work, less than 150 minutes daily moderate-intensity work, less than 150 minutes daily vigorous/moderate recreational activities, or less than 150 minutes daily walking/bicyclingIntense exercise: greater than 75 minutes daily vigorous-intensity work, greater than 150 minutes daily moderate-intensity work, greater than 150 minutes daily vigorous/moderate recreational activities, or greater than 150 minutes daily walking/bicycling

in particular, evidence from clinical trials and observational studies examining composite risk factor control have shown substantial benefits in terms of CVD outcomes. In the Steno-2 Study, intensive therapy including glucose, antihypertensive, antiplatelet, and lipid-lowering treatments was shown to reduce CVD death by 57% and CV events by 59% when compared to conventional therapies.[13] When extended over 21 years, there was a 40% reduced mortality, even years after the conclusion of the randomized trial,[1] suggesting the body may have a metabolic memory for being treated well for multiple risk factors. The Bypass Angioplasty Investigation Revascularization 2 Diabetes study examined the relationship between CV control goals (nonsmoking status, BP <130/80 mm Hg, HbA1c <7%, non-HDL-C <130 mg/dL, and TG <150 mg/dL) and CVD events and survival, and found that having a greater number of risk factors controlled was associated with decreased risk of death, myocardial infarction (MI), and stroke.[2] Furthermore, 5 secondary prevention parameters were included in the Trial Evaluating Cardiovascular Outcomes with Sitagliptin, including aspirin and ACE-I/ARB use, lipid and BP control, and nonsmoking status, and showed that those with >2 parameters met had a 40% lower risk of CVD events.[14] Another study conducted in the UK found that controlling

Table 2
Proportion of patients at goal for individual risk factors

Variable	Total (n = 1179, N = 19.7M)	Cardiovascular disease		p Value
		No (n = 890, N = 15.0M)	Yes (n = 289, N = 4.7M)	
HbA1c*	606 (11.0M, 55.8%)	400 (7.6M, 50.4%)	206 (3.4M, 73.3%)	0.0001
BP < 130/80 mm Hg	559 (10.1M, 51.3%)	423 (7.5M, 49.8%)	136 (2.6M, 56.1%)	0.1152
†LDL-C <100 mg/dL No CVD <70 mg/dL CVD	257 (10.9M, 49.3%)	213 (9.5M, 56.8%)	44 (1.4M, 26.4%)	<0.0001
Nonsmoking status	982 (16.6M, 84.3%)	739 (12.6M, 83.9%)	243 (4.0M, 85.6%)	0.6381
BMI <30 kg/m^2	488 (7.0M, 35.7%)	377 (5.5M, 36.6%)	111 (1.5M, 32.9%)	0.3829
BMI <25 kg/m^2	141 (1.8M, 9.1%)	115 (1.5M, 9.8%)	26 (0.3M, 6.9%)	0.1118

Numbers were displayed as frequency, weighted frequency, and weighted percentage.
Abbreviations: HbA1c = glycated hemoglobin, BP = blood pressure, LDL-C = low-density lipoprotein cholesterol, BMI = body mass index
* HbA1c<7% for those without CVD and <8% for those with CVD.
† LDL-C values were only available among n = 552 (N = 22.2M) subjects who were randomly assigned to a morning fasting session. Of the 552, n = 409 (N = 16.7M) had no CVD and n = 143 (N = 5.5M) had CVD. A different weighted procedure was applied for population estimation.

HbA1c, total cholesterol, BP, and smoking reduced CVD mortality and CV event risks in patients with T2DM and CKD.[4] Finally, a study of patients in the Swedish National Diabetes Register suggested that those at target control for HbA1c, LDL-C, BP, smoking, and albuminuria had no excess risk of death, stroke, or MI, but still had excess risk of heart failure.[5]

Our previous report from NHANES 1999 to 2010[6] identified a positive improvement of CVD risk factor control in T2DM adults from 2000 to 2010 with the latest control proportions of patients at target control being 55.5%, 52.8% and 54.4% for HbA1c, BP and LDL-C, respectively. However, our more recent results do not demonstrate improvement since then, finding similar proportions of patients at target control with 55.8%, 51.3% and 49.3% for these factors, respectively. However, we note composite 3-risk-factor control (HbA1c, LDL-C, and BP) to be lower from our earlier results (17.3% vs 24.9%), possibly because of revised definitions used (e.g., LDL-C <70 mg/dl for those with CVD) which indicates a significant challenge for the treatment of persons with diabetes. As few improvements have been observed over the years, new strategies for risk factor management are called for in clinical practice.

The results of our study can be compared to recently published findings from the US Diabetes Collaborative Registry (DCR), which used patient electronic medical record data acquisition. This study compared to the present one showed a similar proportion of T2DM patients at LDL-C control (48.6% vs 49.3%), nonsmoking (85.2% vs 84.3%), and that are at composite control for HbA1c, BP, LDL-C, and nonsmoking status (13.0% vs 16.0%). The DCR did, however, demonstrate a higher proportion of patients at HbA1c control (73.6% vs 55.8%) but lower proportion at BP control (40.3% vs 51.3%). Although, the DCR comprises of a large and diverse group of practices nationwide, the selection of practices does not ensure representation to the US population, nor is there sample weighting such as available in NHANES allowing for extrapolation to the greater US population.[14]

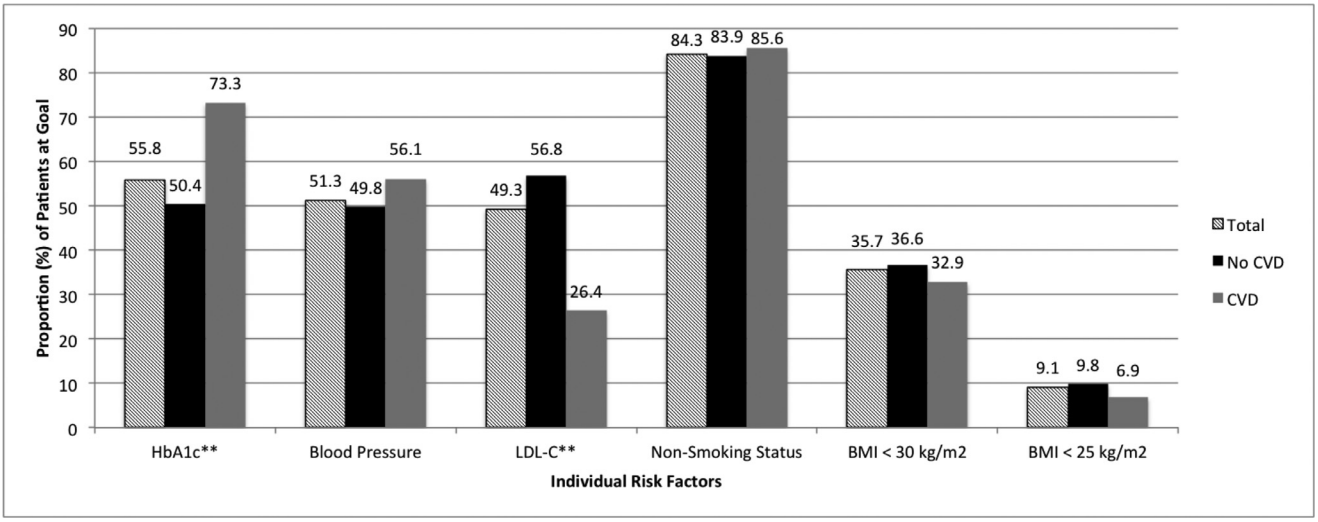

Figure 1. Proportion of patients at goal for individual risk factors. Abbreviations: HbA1c = glycated hemoglobin, LDL-C = low-density lipoprotein cholesterol, BMI = body mass index. Targets: HbA1c <7% no CVD, <8% CVD, blood pressure <130/80 mm Hg, LDL-C <100 mg/dL no CVD, <70 mg/dL CVD. p values for significant comparisons between those with and without CVD: HbA1c = 0.0001, LDL-C <0.0001

Table 3
Proportion of patients at goal for composite risk factors

Variable	Total (n = 552, N = 22.2M)	No CVD (n = 409, 16.6M)	CVD (n = 143, 5.5M)	p Value
HbA1c, BP, and LDL-C	75 (3.8M, 17.3%)	61 (3.3M, 19.7%)	14 (0.5M, 9.8%)	0.0515
HbA1c, BP, LDL-C, and nonsmoking status	65 (3.5M, 16.0%)	56 (3.1M, 19.0%)	9 (0.4M, 6.8%)	0.0057
HbA1c, BP, LDL-C, nonsmoking status, and BMI <30kg/m^2	35 (1.7M, 7.9%)	31 (1.6M, 9.6%)	4 (0.1M, 2.7%)	0.0254

Numbers were displayed as frequency, weighted frequency, and weighted percentage.
Abbreviations: HbA1c = glycated hemoglobin, BP = blood pressure, LDL-C = low-density lipoprotein cholesterol, BMI = body mass index.
Targets: HbA1c <7% no CVD and <8% CVD, BP < 130/80 mm Hg, LDL-C < 100 mg/dL no CVD and <70 mg/dL CVD.
Composite risk factors including for HbA1c, BP, LDL-C, nonsmoking status, and BMI <25 kg/m^2 is not included in this table because of small sample size at target (Total n = 12, No CVD n = 12, CVD n = 0).

BMI remains the measure at worst control among CVD risk factors studied, with only 9.1% of our US adult sample at a target of <25 kg/m^2. Clinically significant weight loss in persons with T2DM is associated with improved DM and CVD risk factor control.[15] Previous studies[16] have also identified significantly higher CHD, CVD, and total mortality rates in those with metabolic syndrome (MetS), with elevated glucose, BMI, and waist circumference being a part of the MetS diagnosis criteria. We note <10% of the US T2DM population is at target control for BMI (<25 kg/m^2), showing no improvement over recent years given our earlier data[6] showing the proportion of patients at this BMI target to be 10.3% in 2010. The increase in obesity over recent years in the US population (30.5% in 2000 to 37.7% in 2014)[17] warrants improved efforts, especially among persons with T2DM, to maintain optimal weight control. Newer antidiabetic therapies recently demonstrated and indicated for CVD risk reduction in persons with both DM and CVD, including certain sodium glucose cotransporter 2 inhibitors and glucagon-like peptide 1 receptor agonists, while providing modest HbA1c lowering, have been recently shown to have other benefits such as BP and weight reduction. Greater use of

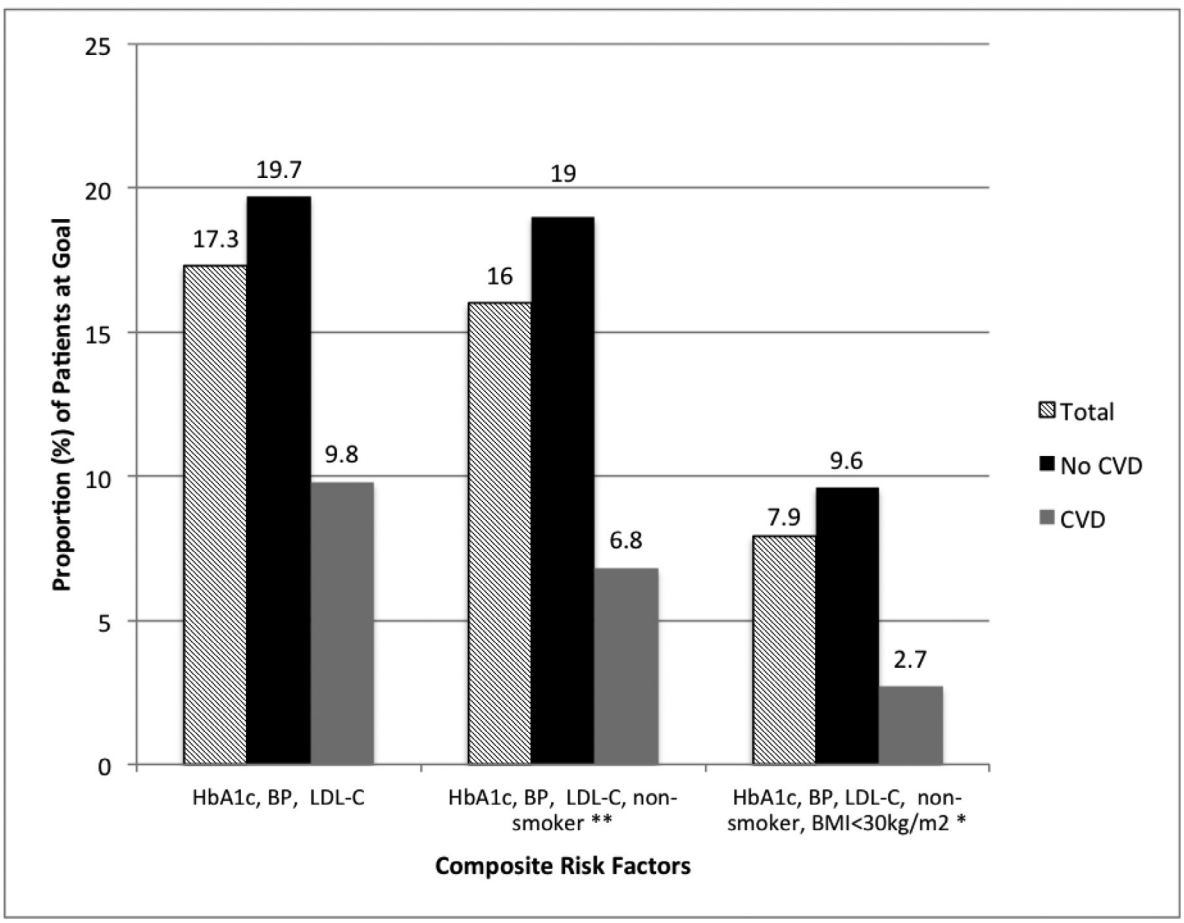

Figure 2. Proportion of patients at goal for composite risk factors. Abbreviations: HbA1c = glycated hemoglobin, BP = blood pressure, LDL-C = low-density lipoprotein cholesterol, BMI = body mass index. Targets: HbA1c <7% no CVD, <8% CVD, blood pressure <130/80 mm Hg, LDL-C <100 mg/dL no CVD, <70 mg/dL CVD. p values for significant comparisons between those with and without CVD: HbA1c, BP, LDL-C, and nonsmoking = 0.0057, HbA1c, BP, LDL-C, nonsmoking, and BMI <30 kg/m^2 = 0.0254

these therapies may provide further benefit for composite CVD risk factor control as well as address the substantial residual risk of CVD in these patients.[18]

There are several strengths and limitations in our study. One significant strength is that we calculated the estimated proportion of patients with T2DM at target control according to population-based data, which can be extrapolated to the US noninstitutionalized civilian population through a weighted procedure. Second, our sample is diverse. Starting in 2010, NHANES further categorized its ethnic groups into non-Hispanic White, Mexican American, other Hispanic, non-Hispanic Black, and non-Hispanic Asian. Third, NHANES has standardized measurement of risk factors and ascertainment of prevalent disease status by questionnaire. However, given the nature of the cross-sectional survey, laboratory test results are dependent on a 1-time exam that can be biased according to examinee conditions during the survey. Moreover, we have limited self-reported medical history, such as on prior CVD status, which is based only on the measures we included, and we did not have information on other criteria such as percutaneous interventions, bypass surgery, or multivessel angiographic disease.

In summary, our study has found that only about half of US T2DM adults are at target control for individual risk factors of HbA1c, BP and LDL-C. However, when examined as composite risks, including nonsmoking status, less than one-fifth of US adults with T2DM are at all 4 of these targets, and under 5% if normal BMI is further required. Achievement of composite targets is worse for those with pre-existing CVD who have the highest risk of future CVD events when these factors are left inadequately controlled. These data demonstrate the need for improved clinical inertia among healthcare providers to ensure the composite of these risk factors is regularly evaluated, with appropriate lifestyle interventions and pharmacologic therapies provided to address them.

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