

# Optimal Management of Diabetes Among Overweight and Obese Adults

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**T**he prevalence of obesity in the United States has risen dramatically in the past 50 years and continues to rise. Currently, more than 30% of the American population is considered obese.<sup>1,2</sup> Obese individuals have more comorbidities and a higher rate of healthcare utilization than nonobese individuals.<sup>1,3</sup> There are well-documented associations between obesity and several chronic conditions, including diabetes.<sup>4-6</sup> Diabetes is associated with high rates of cardiovascular disease, retinopathy, peripheral vascular disease, neuropathy, and nephropathy.<sup>7</sup> Many of these complications can be delayed or prevented with effective management; however, many people with diabetes are not meeting the American Diabetes Association (ADA) goals for risk factor control.<sup>8-11</sup> An analysis of the National Health and Nutrition Examination Survey 2001-2002 found that the percentage of adults in the United States with diabetes who were not at goal was 50% for glycated hemoglobin (A1C), 53% for blood pressure (BP), 65% for low-density lipoprotein cholesterol (LDL-C), and 49% for triglycerides.<sup>10</sup>

Obese patients have reported feeling stigmatized by healthcare professionals<sup>12</sup>; those who feel stigmatized may be more likely to delay or avoid seeking healthcare services.<sup>13</sup> In addition, a number of studies have documented negative healthcare provider attitudes toward obese patients,<sup>12,14,15</sup> perhaps making it less likely that healthcare professionals will work with their obese patients on behavioral changes. The extent of the impact of stigmatization and bias on quality of care in obese patients is not well understood, especially for those patients with chronic health conditions such as diabetes. Most of the available research relies on self-report rather than using medical record data to assess actual utilization.<sup>16,17</sup>

The aim of this study was to examine whether there were weight-related disparities in risk factor screening and control rates based upon the National Committee for Quality Assurance (NCQA) Healthcare Effectiveness Data and Information Set (HEDIS) performance measures for diabetes among members of a large, integrated managed healthcare organization. The HEDIS performance measures are widely used by

health plans in the United States to measure performance on quality of care and services across a range of health conditions including diabetes.<sup>18</sup>

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**Objective:** To explore potential weight-related disparities in the quality of care for adults with diabetes in a large managed care health plan according to recommended quality indicators.

**Design:** Cross-sectional analysis.

**Methods:** A total of 164,721 Kaiser Permanente Southern California members aged 18 to 75 years with diabetes who had 1 or more health encounters with a weight and height measurement between July 1, 2007, and June 30, 2008, were identified. The 9 Healthcare Effectiveness Data and Information Set (HEDIS) quality-of-care measures were examined: 4 screening measures (glycated hemoglobin [A1C], retinal examination, lipids, and nephropathy) and 5 control measures (2 for A1C, 2 for blood pressure, and 1 for low-density lipoprotein cholesterol [LDL-C]), using data extracted from electronic health records (EHRs). Weight and height from the EHR were used to calculate body mass index (BMI). Adjusted odds ratios and 95% confidence intervals were calculated to examine the association between BMI categories and HEDIS quality-of-care measures.

**Results:** Among individuals with diabetes, 12% were in the healthy-weight category, 30% were overweight, and 28%, 17%, and 14% were in obese categories I, II, and III, respectively. Overweight and obese individuals were more likely than their healthy-weight counterparts to have screening measures performed. However, among those tested or screened, overweight and obese individuals were less likely to have their A1C and blood pressure controlled. LDL-C control increased as BMI increased.

**Conclusions:** These findings highlight the need for interventions to improve glycemic and blood pressure control among overweight and obese patients with diabetes.

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**For author information and disclosures, see end of text.**

### Take-Away Points

This study highlights the need for increased attention by patients, providers, and healthcare systems to improving blood pressure and glycemic control among overweight and obese patients with diabetes.

■ Overweight and obese individuals were more likely than their healthy-weight counterparts to have glycated hemoglobin (A1C) testing, retinal examinations, and lipid and nephropathy screenings performed.

■ Among those tested or screened, overweight and obese individuals were less likely to have their A1C and blood pressure controlled; low-density lipoprotein cholesterol control increased as body mass index increased.

measurement was recorded during the study period, the first recorded measurement was used.

Quality-of-care measures for comprehensive diabetes care specified by NCQA included 4 screening measures: A1C testing, eye (retinal) examination, LDL-C screening, and medical attention for nephropathy (microalbuminuria screening or evidence of nephropathy), and 5 control measures: A1C control

( $\leq 9.0\%$  [ $\leq 75$  mmol/mol] and  $< 7.0\%$  [ $< 53$  mmol/mol]), LDL-C control ( $< 2.6$  mmol/L), and BP control ( $< 130/80$  mm Hg and  $< 140/90$  mm Hg) (Table 1).<sup>21</sup> The ADA recommendations for patients with diabetes are BP less than 130/80 mm Hg and A1C less than 7.0%.<sup>8</sup> All recorded quality-of-care measures were performed in the HEDIS measurement year between July 1, 2007, and June 30, 2008, with the exception of lipid screening and retinal examination, which could be performed in the measurement year or the year prior to the measurement year.

Age was calculated from date of birth to July 1, 2007; income was based on 2000 census data geocoded at the block level; and race/ethnicity and number of healthcare encounters during the study period were ascertained from administrative data. All persons of Hispanic ethnicity were coded as Hispanic, regardless of race, and then non-Hispanic persons were categorized based on their race. Individuals with no information on race or Hispanic ethnicity were categorized as unknown. As an overall measure of disease burden, the Deyo adaptation of the Charlson Comorbidity Index was calculated using ICD-9 diagnosis codes from inpatient and outpatient encounters within 12 months prior to the measurement period.<sup>22</sup>

### Statistical Analysis

Descriptive statistics were used to describe demographic characteristics (age, sex, race/ethnicity, and income) by the BMI categories. Means and standard deviations (SDs) were calculated for continuous variables, and percentages were calculated for categorical variables. Demographic characteristics were compared across BMI categories using the Cochran-Armitage trend test for categorical variables and analysis of variance for continuous variables.

Performance rates for each NCQA HEDIS measure were calculated as the percentage of individuals who achieved the measure overall and by BMI category. According to HEDIS specifications, patients without a BP measure or laboratory test result during the study period were counted as not being at goal for that measure.<sup>21</sup> The Cochran-Armitage trend test was used to assess trends in performance rates with increasing BMI.

## METHODS

### Setting

This study was conducted within Kaiser Permanente Southern California (KPSC), an integrated healthcare system that provides comprehensive health services for approximately 3.5 million residents of southern California. Members of KPSC are socioeconomically diverse and broadly representative of the general population of southern California.<sup>19</sup>

### Study Population and Sample Selection

We identified all KPSC members aged 18 to 75 years continuously enrolled in the health plan between July 1, 2007, and June 30, 2008, with no more than one 45-day gap in enrollment and with a diagnosis of diabetes mellitus (N = 169,077). A diabetes diagnosis was based on the HEDIS specifications of at least 2 outpatient or 1 inpatient *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes of 250, 357.2, 362.0, 366.41, or 648.0, or having been dispensed insulin or an oral antihyperglycemic medication (excluding metformin alone) during the measurement period. We then excluded 3901 members (2.3%) who did not have at least 1 health encounter with a recorded weight and height measurement during the study period and 455 with a body mass index (BMI) of less than 18.5 kg/m<sup>2</sup> (0.3%), resulting in a final study sample of 164,721 individuals. Information from KPSC electronic health records (EHRs) including encounter, pharmacy, and laboratory data were linked with administrative membership information for these analyses. The study protocol was reviewed and approved by the KPSC Institutional Review Board.

### Main Measures

Body mass index was calculated by dividing weight in kilograms by height in meters squared and categorized according to World Health Organization guidelines: healthy weight was a BMI of 18.5 to 24.9 kg/m<sup>2</sup>, overweight was a BMI of 25.0 to 29.9 kg/m<sup>2</sup>, obese class I was a BMI of 30.0 to 34.9 kg/m<sup>2</sup>, obese class II was a BMI of 35.0 to 39.9 kg/m<sup>2</sup>, and obese class III was a BMI of 40 kg/m<sup>2</sup> or more.<sup>20</sup> If more than 1 BMI

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**Table 1.** HEDIS Quality-of-Care Measures for Comprehensive Diabetes Care

Test or Screening	HEDIS Definition for Comprehensive Care
A1C testing	One or more A1C tests performed during measurement year
A1C ≤9.0% (≤75 mmol/mol)	At least 1 A1C test performed during the measurement year and most recent result ≤9.0% (≤75 mmol/mol)
A1C <7.0% (<53 mmol/mol)	At least 1 A1C test performed during the measurement year and most recent result <7.0% (<53 mmol/mol)
Retinal examination performed	Retinal or dilated eye examination performed by an eye care professional in the measurement year, or a negative retinal eye examination (no evidence of retinopathy) in the year prior to the measurement year
Lipid screening	At least 1 lipid profile performed in the measurement year or the previous year
LDL-C <2.6 mmol/L	At least 1 LDL-C result in the measurement year and most recent result <2.6 mmol/L
Medical attention for nephropathy	Microalbuminuria screening (24-hour timed urine or spot urine) or documented evidence of nephropathy during measurement year
Blood pressure <130/80 mm Hg	Blood pressure controlled (<130/80 mm Hg) during the measurement year and at the most recent visit
Blood pressure <140/90 mm Hg	Blood pressure controlled (<140/90 mm Hg) during the measurement year and at the most recent visit

HEDIS indicates Healthcare Effectiveness Data and Information Set; LDL-C, low-density lipoprotein cholesterol.

Multivariate logistic regression was used to examine the association between BMI and the individual HEDIS measures after adjusting for age, sex, race/ethnicity, income, number of comorbidities, and number of healthcare encounters during the study period. The presence of a linear trend across BMI categories was tested by including the median of each BMI category as a continuous independent variable in the model. All analyses were performed using SAS software version 9.2 (SAS Institute Inc, Cary, North Carolina).

## RESULTS

### Description of the Study Sample

The study sample was composed of 164,721 individuals with diabetes and a mean age of 56.9 (11.2) years. Overall, 12% of individuals were in the healthy-weight category, 30% were overweight, and 28%, 17%, and 14% were in obese categories I, II, and III, respectively (Table 2). About half of the individuals were male, approximately one-third were Hispanic, and slightly more than half resided in a census block with a household income of less than \$50,000. The mean (SD) BMI was 32.4 kg/m<sup>2</sup> (11.2 kg/m<sup>2</sup>), and BMI was inversely related to mean age. The proportion of males was lower at higher BMI. The proportions of whites and blacks and individuals in the lowest 2 income categories increased with increasing BMI (*P* for trend <.0001).

### Screening and Control Rates

Nearly all (94%) individuals had an A1C test, 58% had a retinal examination, 93% had a lipid screening profile performed, and 95% had a documented screening for or evidence

of nephropathy. In unadjusted analyses, there was a statistically significant trend toward an increase in performance rates for all screening measures with increasing BMI. Conversely, levels of control for A1C, LDL-C, and BP all decreased as BMI increased. Only 41% of all individuals achieved the optimal control target of <7% (<53 mmol/mol) for A1C. More than half (58%) achieved the LDL-C goal of less than 2.6 mmol/L, 82% achieved the BP goal of less than 140/90 mm Hg, and 54% achieved the BP goal of less than 130/80 mm Hg. The largest disparity across BMI categories was seen for BP less than 130/80 mm Hg, where control decreased across all BMI categories from 63% in healthy-weight individuals to 46% of individuals in obese class III (data not shown).

After adjusting for age, sex, race/ethnicity, income, number of comorbidities, and number of healthcare encounters, overweight and obese individuals were more likely to have all 4 screening measures (A1C testing, retinal examination, nephropathy screening, and lipid screening) compared with their healthy-weight counterparts (Figure). The odds of having a retinal examination, however, did not consistently increase with increasing BMI (*P* for trend = .4410). Of note, the adjusted odds ratios (ORs) (95% confidence interval [CI]) of nephropathy screening in overweight and obese class I, II, and III individuals compared with healthy-weight individuals were 1.17 (1.08-1.27), 1.44 (1.32-1.57), 1.62 (1.48-1.78), and 1.84 (1.66-2.04), respectively (*P* for trend <.0001). After adjustment, overweight and obese individuals were less likely to have optimal glycemic control (A1C <7% [<53 mmol/mol]) and BP control (<130/80 mm Hg) than their healthy-weight counterparts. In contrast, LDL-C control consistently increased across BMI categories, with class III obese individuals

■ **Table 2.** Characteristics of Study Participants by Body Mass Index

Characteristics	Total	Body Mass Index Category, kg/m <sup>2</sup>					P for trend
		18.5-24.9	25-29.9	30-34.9	35-39.9	≥40	
<b>No. (%)</b>	164,721 (100)	19,493 (11.8)	49,481 (30.0)	45,901 (27.9)	27,664 (16.8)	22,182 (13.5)	
<b>Age, y, mean (SD)</b>	56.9 (11.2)	58.5 (12.2)	58.4 (10.8)	57.0 (10.8)	55.4 (11.0)	53.3 (11.1)	<.0001
<b>Male, %</b>	52.0	50.8	59.3	55.2	46.7	36.5	<.0001
<b>Race/ethnicity, %</b>							
Asian	9.4	24.8	13.3	6.0	3.3	1.9	<.0001
Black	12.2	9.4	10.6	12.6	13.6	16.0	<.0001
Hispanic	34.3	26.3	35.5	36.9	35.2	32.2	<.0001
White	30.8	25.4	27.2	31.5	35.2	36.9	<.0001
Other	1.7	1.9	1.7	1.7	1.5	1.6	.002
Unknown	11.5	12.2	11.7	11.3	11.1	11.4	.0006
<b>Income, %<sup>a</sup></b>							
<\$25,000	22.6	21.4	22.1	22.5	23.2	23.9	<.0001
\$25,000-\$49,999	28.1	26.9	27.7	28.2	28.8	29.2	<.0001
\$50,000-\$99,999	34.1	34.3	34.2	34.3	34.0	33.7	.07
≥\$100,000	15.2	17.4	16.0	15.0	14.0	13.2	<.0001
<b>BMI, kg/m<sup>2</sup>, mean (SD)</b>	32.4 (11.2)	23.0 (1.5)	27.6 (1.4)	32.3 (1.4)	37.2 (1.4)	45.4 (5.3)	NA
<b>Charlson Comorbidity Index score, %</b>							
0	6.3	5.0	5.9	6.5	7.0	7.0	<.0001
1	43.1	44.3	44.4	44.0	41.5	39.7	<.0001
2	24.1	23.2	24.1	23.6	24.8	24.8	<.0001
3+	26.5	27.5	25.6	25.9	26.7	28.5	<.0001
<b>No. of visits, mean (SD)<sup>b</sup></b>	11.9 (12.7)	12.3 (14.0)	11.3 (12.2)	11.6 (12.1)	12.2 (12.4)	13.1 (13.8)	<.0001

BMI indicates body mass index; NA, not applicable.  
<sup>a</sup>Data are based on 2000 census data geocoded at the block level.  
<sup>b</sup>Mean number of outpatient visits during measurement year.

being more likely (OR = 1.23; 95% CI, 1.17-1.29) to achieve goal compared with their healthy-weight counterparts.

## DISCUSSION

Among a diverse population of individuals with diabetes, our findings suggest that BMI was not a barrier to care for recommended screenings and examinations. We found that those individuals who were overweight and obese were more likely than their healthy-weight counterparts to have the recommended screening tests and examinations performed but were less likely to have their glucose and BP controlled. Interestingly, we found the opposite for LDL-C control, which increased with increasing BMI.

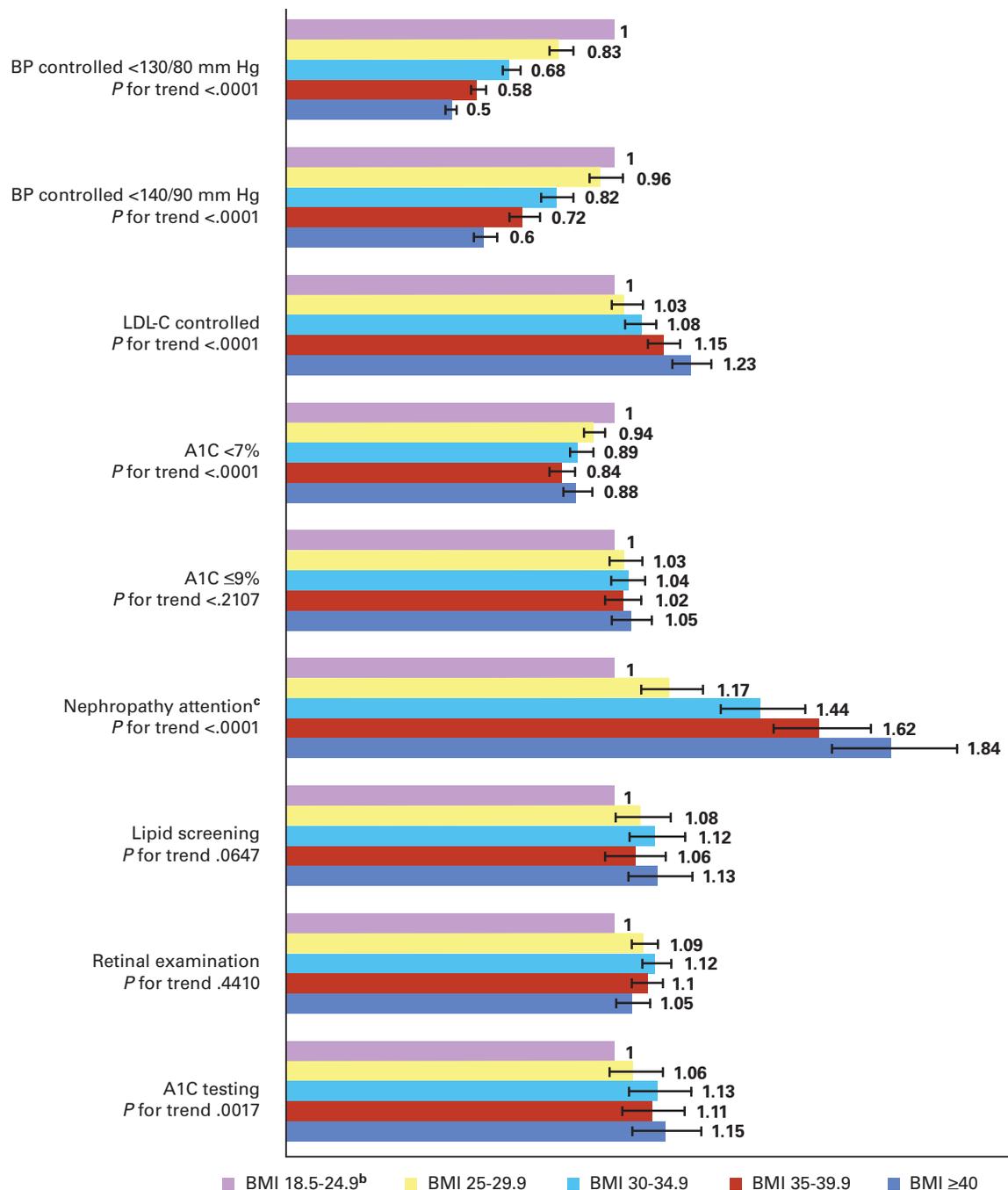
Our findings are similar to those of several other studies; however, those studies did not exclusively include individuals with diabetes. Data from the California Men's Health Study

demonstrated that overweight and obese men were significantly more likely to have their glucose, cholesterol, and triglycerides tested regardless of whether they had diabetes.<sup>23</sup> In the National Ambulatory Medical Care Survey, obese participants were more likely to receive glucose and A1C testing, although it is not known what proportion of these patients had diabetes.<sup>24</sup> In a quality-of-care study among Medicare beneficiaries and recipients of Veterans Health Administration healthcare services, a higher BMI was associated with increased odds of receiving A1C testing and lipid screening among patients with diabetes.<sup>16</sup> A study among primary care patients examining diabetes and lipid screening rates found that higher BMI predicted higher screening rates for triglycerides, high-density lipoprotein cholesterol, LDL-C, and A1C; however, only 10% of this study population had diabetes.<sup>25</sup>

None of these aforementioned studies assessed the HEDIS-recommended control measures for diabetes care. To our

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**Figure.** Adjusted Odds Ratio (95% CI) of Measures of Quality of Care for Diabetes by Body Mass Index<sup>a</sup>



A1C indicates glycated hemoglobin; BMI, body mass index; BP, blood pressure; CI, confidence interval; LDL-C, low-density lipoprotein cholesterol.

<sup>a</sup>All odds ratios were adjusted for age, sex, race/ethnicity, income, number of visits, and comorbidity.

<sup>b</sup>Reference group was patients with a body mass index from 18.5 to 24.9 kg/m<sup>2</sup>.

<sup>c</sup>Microalbuminuria screening (24-hour timed urine or spot urine) during measurement year.

knowledge, only 1 study to date has examined control rates. Rose and colleagues<sup>26</sup> found that among nearly 50,000 individuals over an 18-month period, obese individuals were less likely to have good control of BP, LDL-C, and fasting glucose compared with healthy-weight individuals.

Despite evidence that overweight and obese individuals may avoid seeking healthcare services due to stigmatization, those with the added burden of chronic disease such as diabetes seek medical care more frequently,<sup>27</sup> thus giving healthcare providers additional opportunities to perform

screening examinations and tests. However, since retinal examinations are performed by ophthalmologists outside the primary care setting, increased use of healthcare services among individuals with a chronic disease may not extend to retinal examinations, thus potentially explaining the low screening rates we found for this measure. The high rates of nephropathy screening among obese patients in our study may be related to the high prevalence of nephropathy among people with diabetes and the severity of treatment for end-stage renal disease. Additionally, obesity is a possible risk factor for nephropathy.<sup>28</sup>

Similar to Rose and colleagues,<sup>26</sup> we found weight-related differences for BP control in our study. We also found weight-related differences in A1C control. These findings are important because controlling BP and A1C can reduce the risk of microvascular complications such as nephropathy and cardiovascular disease among persons with diabetes.<sup>8</sup> The unexpected finding of increased lipid control with increasing BMI may be due to the ADA recommendation of statin therapy regardless of lipid levels for patients with diabetes who have cardiovascular disease or 1 or more risk factors for cardiovascular disease.<sup>8</sup> Additionally, obese individuals with elevated LDL-C from a subset of the Framingham Offspring and Third Generation cohorts were found to be more likely to be treated with lipid-lowering agents.<sup>5</sup>

Although we found higher screening rates among overweight and obese individuals, the lower rates of glycemic control and BP control suggest that these patients may need additional encouragement and tools to achieve good control. Provider-led interventions to achieve BP control, however, have shown mixed results.<sup>29</sup> Promising results were seen with nurse-led interventions using structured algorithms to improve BP control in people with diabetes.<sup>30</sup> Similar nurse-led interventions could be implemented to improve glycemic control and BP control among patients with diabetes. Home BP monitoring and automated telephone interventions have proved to be effective at reducing BP and blood glucose levels and may be cost-effective strategies at the population level.<sup>31-33</sup> Moreover, the pharmacist-led home BP monitoring program achieved greater impact among participants with diabetes.<sup>32</sup>

Several limitations of these analyses should be considered. The main limitation is that we only included individuals with a recorded BMI. It is possible that individuals without a documented BMI differ from the study population. However, the number of individuals missing height and weight measurements to calculate BMI was only 2.3% of the sample (n = 3901). Due to the fact that this study was conducted using data from 1 integrated healthcare system in 1 region of the country, our results may not be generalizable to populations in other geographic areas or in other types of healthcare delivery systems.

The large sample size allowed for the detection of small, statistically significant differences. While these differences may not be clinically relevant on an individual level, they are indicative of a larger trend on a population level. Further, KPSC has laboratory facilities in many of its medical centers, and results are available online for review by members after the tests are completed. This convenience and availability of results may increase the overall likelihood of patients completing recommended blood tests. Finally, this study adjusted for but did not assess the influence of race/ethnicity on screening performance or control rates. However, 1 study found that race/ethnicity was not consistently associated with lower screening rates in black and Hispanic populations compared with whites.<sup>34</sup>

The strengths of this study include its large and racially/ethnically diverse composition that is reflective of the general population in southern California, a broad age range, and the use of information in the EHR rather than self-reported BMI data. Misclassification errors can result with the use of self-reported BMI data because individuals are likely to under-report weight and to over-report height.<sup>35</sup>

Among patients with diabetes enrolled in a large integrated managed care organization, we found weight-related disparities in A1C and BP control. These findings support the need for increased attention by patients, providers, and healthcare systems to improving BP and glycemic control among overweight and obese patients with diabetes. This study also highlighted the need for better retinal examination performance across all BMI categories, including for healthy-weight individuals. Future studies should focus on identifying modifiable healthcare system, provider, and patient factors associated with health outcomes in overweight and obese individuals with diabetes.

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