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RESEARCH ARTICLE

Albuminuria Screening in People With Type 2 Diabetes in a Managed Care Organization

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Introduction: Albuminuria—an increased amount of urine albumin, in milligrams, adjusted for grams of urine creatinine—is an early marker of diabetic kidney disease. Several new classes of medications are now available that effectively lower albuminuria levels with the potential to delay or prevent the progression of diabetic kidney disease. However, screening for albuminuria in the U. S. is low in population-based studies (<10% to ~50% at most). In this study, we examine whether screening for albuminuria was improved in an integrated model of healthcare delivery following the recommendations of the National Committee for Quality Assurance mandate (an umbrella group for the managed healthcare industry) to screen for albuminuria.

Methods: We examined screening for albuminuria over a 2-year period among people with Type 2 diabetes in a U.S. HMO with an electronic medical record, onto which automated laboratory ordering for albuminuria could be added when a patient appeared at the laboratory (for any reason) if albuminuria testing had not been obtained within the previous 365 days. Participants under this plan received diabetes education at no cost and panel managers to guide their diabetes care. Logistic regression using data from 2020 and 2021, separately, evaluated the relationship between patient characteristics and the likelihood of albuminuria screening.

Results: There were 20,688 and 22,487 participants with Type 2 diabetes mellitus in 2020 and 2021, respectively, who were analyzed. Approximately 80% were screened for albuminuria in both years. African American participants and those aged >64 years were more likely to have completed albuminuria screening. Screened individuals had lower HbA1c, blood pressure, and low-density lipoprotein cholesterol levels than those who were not screened.

Conclusions: In an integrated healthcare model, it is possible to achieve consistently high rates of albuminuria screening in people with Type 2 diabetes, especially in groups at high risk for kidney disease.

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INTRODUCTION

Diabetic kidney disease (DKD) is characterized by a progressive increase in urine albumin excretion, followed by a decline in glomerular filtration rate, ultimately leading to end-stage renal disease.[1,2] Assuming that elevated levels of urine albumin are the earliest sign of DKD and that early interventions to lower urine albumin levels forestall the progression of DKD,[3,4] screening for elevated urine albumin is of great clinical importance if efforts are to be made to prevent or lower DKD in its early phases. Once advanced, DKD is inexorable and irreversible. Renin-angiotensin-aldosterone system (RAAS) inhibitors and new medications, such as sodium-glucose cotransporter 2 inhibitors, glucagon-like peptide 1, and nonsteroidal mineralocorticoid receptor antagonists,[5–7] lower urine albumin levels prior to estimated glomerular filtration rate (eGFR) decline, emphasizing the importance of urine albumin screening, detection, and management.

Four recent U.S. population–based studies of people with or without diabetes show screening rates for urine albumin concentrations, measured in milligrams, adjusted for urine creatinine concentration, measured in grams—termed albuminuria (ALB)—to be very low (<10%)[8] or not more than ∼50%.[9–11] The reasons for this are not well studied but likely include (1) physician-level factors, such as lack of awareness of urine albumin screening guidelines, lack of financial incentive to do such screening, and clinical inertia (the failure to start or intensify a therapy when indicated)[12]; (2) patient-level factors, such as limited access to care or little knowledge that diabetes can be associated with kidney disease, especially because it is largely asymptomatic until advanced; and (3) system-level factors, such as uncoordinated care among multiple providers who are not within an integrated system of care and the absence of urine albumin test in laboratory panels used for monitoring general health. All these factors culminate in a lost opportunity for disease prevention.

The Healthcare Effectiveness Data and Information Set (HEDIS) is a widely used set of performance measures in the managed care industry, developed and maintained by the National Committee for Quality Assurance.[13] HEDIS allows consumers to compare health plan performance with other plans and with national or regional benchmarks. Prepaid managed care organizations provide guideline-based medical care as part of their mission to improve the health of their participants.[14] All physicians have access to the participant's record, thereby allowing for coordinated care. Electronic medical record (EMR) reminders of guideline practices are provided at many levels. Financial barriers to access are diminished because health insurance plans are prepaid, and screenings have no to small copays. In 2020, a new HEDIS quality measure for diabetic nephropathy screening was added.[15] This included urine ALB levels and eGFR based on serum creatinine levels (an information card for DKD screening from the National Committee for Quality Assurance is available at https://www.niddk.nih.gov/health-information/kidney-disease/race-ethnicity).

In this study, we report on the HEDIS results for 2020 and 2021. We hypothesize that the mandate to perform ALB screening in people with Type 2 diabetes was rapidly implemented in an integrated healthcare system with an HMO model. We further speculate that screening rates would be largely agnostic regarding age, sex, race, and socioeconomic factors.

METHODS

Kaiser Permanente of Georgia (KPGA) is an integrated healthcare system that serves >3,20,000 individuals in the Atlanta metropolitan and northern Georgia region. KPGA is part of the national Kaiser Permanente medical system. The KPGA population is drawn from the general Atlanta region, and its members are representative of the working Atlanta population. Most of the participants are federal and state employees and those who work for large companies. Approximately 10%–12% have Medicare, and 15%–17% are members through the marketplace (individual plans). KPGA has a pediatric Medicaid program but does not have adult Medicaid participants.

KPGA implemented ALB screening in 2020 to adhere to the published HEDIS guidelines. KPGA provides diabetes health education classes at no cost to increase members' knowledge of diabetes complications and compliance with treatment. The healthcare system also provides diabetes panel managers to a subset of members diagnosed with diabetes who help members navigate their diabetes diagnosis and ensure that they are current on diabetes healthcare screenings and medications.

Automated ordering of HbA1c and serum creatinine for members included in diabetes registries was instituted in KPGA in 2017. This was a quality measure used to monitor and improve health outcomes. In 2020, automated ordering for ALB was included because it became a HEDIS quality measure. Orders for HbA1c, ALB, and serum creatinine were executed electronically (using algorithms embedded in the EMR) if these tests had not been performed within 365 days at any time that the member appeared at the laboratory. For HbA1c, tests are electronically ordered at 180 days and more often if the HbA1c is >9%. Lipid values were not electronically ordered. This study was determined not to be human

subject research by the KPGA IRB, and therefore IRB approval was not needed.

Study Population

This cross-sectional study used EMR data from all adults aged 18–85 years with Type 2 diabetes mellitus any time between January 2020 and December 31, 2021. Members were continuously enrolled with no gap in enrollment of more than 45 days and could be diagnosed in the measurement year or the year before the measurement year. The diagnosis of Type 2 diabetes mellitus was ascertained using ICD-10 Code E11-9. Members diagnosed with end-stage renal disease or on dialysis, those utilizing hospice or palliative care services during the measurement year, those living in a long-term institution or institutional special needs plan facility, and those with diagnoses of advanced illness and/or frailty making it difficult for them to attend a clinic visit were excluded (per HEDIS guidelines). In addition, for HEDIS purposes, proper renal screening requires a serum creatinine and ALB level within the same year. There were 1,132 participants who had ALB screening but did not have a serum creatinine level. In these analyses, they were considered not screened. Figure 1 reports the cohort identification, inclusion criteria, and exclusion criteria used to obtain the descriptive statistics and logistic regression cohorts for both 2020 and 2021.

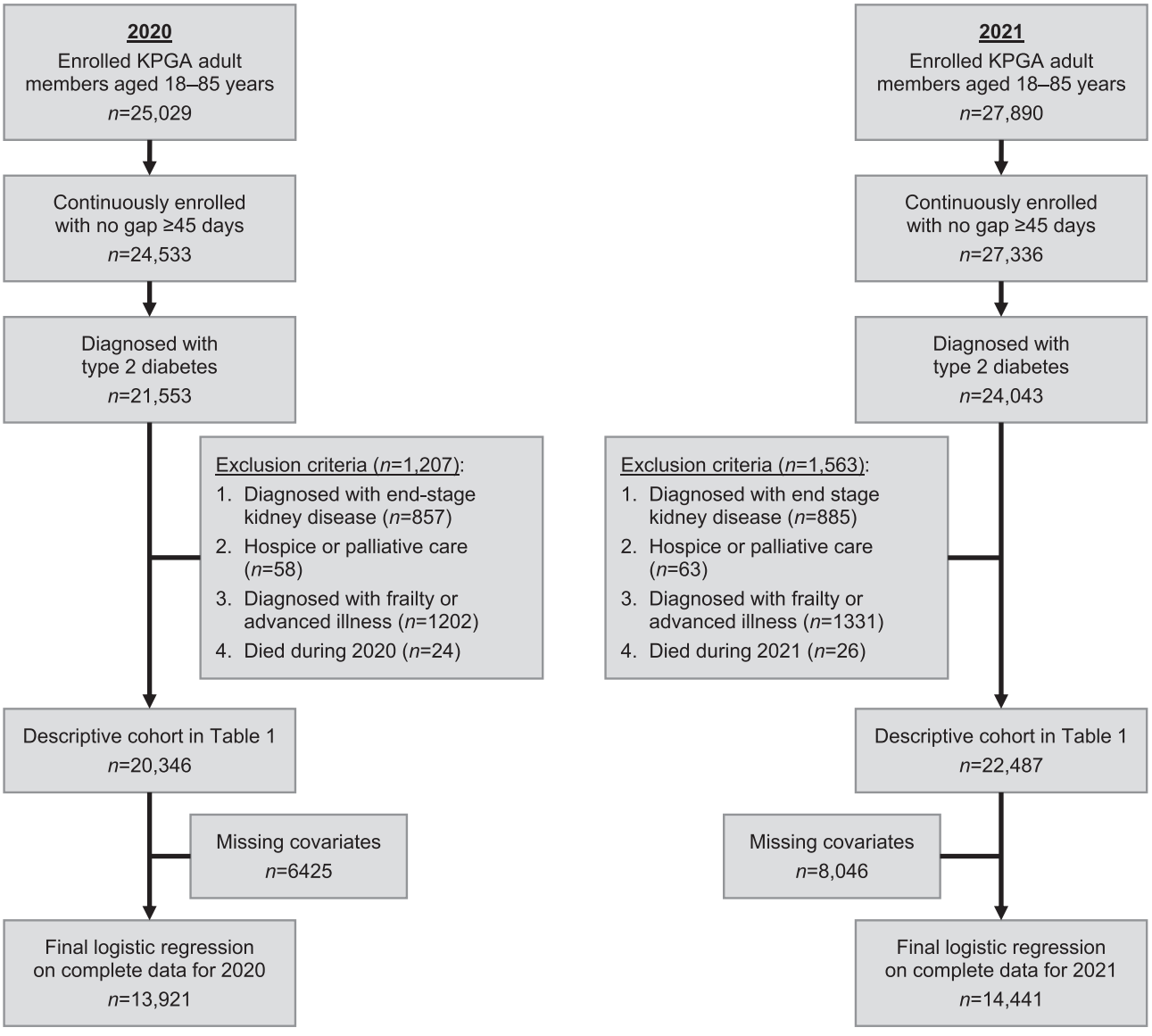

Figure 1. Flow diagrams for cohort identification and selection for the descriptive statistics and logistic regression analyses for 2020 and 2021 cohorts.
KPGA, Kaiser Permanente of Georgia.

To account for the coronavirus disease 2019 (COVID-19) pandemic and its impact on diabetes management, we stratified our sample by calendar year. We individually assessed the data from 2020 and 2021 to determine whether screening rates remained stable.

Measures

The primary outcome was *completion of ALB screening* defined as at least 1 ALB result during a 365-day period. Patient demographics of interest were sex (male or female), race (Asian or Pacific Islander, Black or African American, White, other, and unknown), age as of January of each calendar year, and Atlanta clinical service area (east, west, south, or other). The latter factor was examined to explore whether ALB screening rates varied in different parts of the city within different ethnic, racial, and socioeconomic mixes.

Patient clinical characteristics considered were BMI (kg/m^2) defined as underweight (<18.5), normal (18.5−25), overweight (25.1−29.9), or obese (≥30); blood pressure control (above or below 140/90 mmHg); HbA1c (%) categorized as <7, 7−8.9, and ≥9; use of statins (yes/no); use of oral antidiabetic agents (yes/no); use of insulin (yes/no); and use of RAAS blockade medications (angiotensin-converting enzyme inhibitors [ACEis] and angiotensin II receptor blockers [ARBs]).

Laboratory tests were performed at the central laboratory (Clinical Laboratory Improvement Amendments certified). Values for HbA1c, serum creatinine, eGFR, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, total cholesterol, and ALB are presented as averages and 95% CIs. For analyses, LDL was categorized as normal (<100 mg/dL), near optimal (100−129 mg/dL), borderline high (130−159 mg/dL), high (160−189 mg/dL), or very high (≥190 mg/dL); HDL was categorized as normal (45−60 mg/dL for males, 50−60 mg/dL for females), optimal (≥60 mg/dL for males and females), or high risk (<45 mg/dL for males, <50 mg/dL for females); and eGFR was categorized as normal (≥90 mL/min/1.73 m^2), mildly decreased kidney function (45−89 mL/min/1.73 m^2), moderately decreased kidney function (30−44 mL/min/1.73 m^2), severely decreased kidney function (15−29 mL/min/1.73 m^2), or end-stage renal disease (<15 mL/min/1.73 m^2).

Service area represents the geographic location in which the member received primary care and is based around the Atlanta metropolitan area. We used a Median Household Income estimate and Neighborhood Deprivation Index score, calculated on the basis of the patient's home address, which was geocoded and linked to census tract−level data from the U.S. Census American Community Survey. A higher Neighborhood Deprivation Index indicates more deprivation. Mean household income was categorized as follows for the logistic regression: low income (0% to <67% of median area household income), middle income (67%−200% of median area household income), and high income (>200% median area household income). Time to travel to the primary care facility was also calculated for the 2021 cohort.

Statistical Analysis

Analyses were conducted for each calendar year separately. Descriptive statistics report demographic and patient characteristics overall and stratified by the presence of ALB screening. Chi-square and Student's *t*-tests were used to compare the differences in patient characteristics across screening status for categorical and continuous variables, respectively. Logistic regression analyzed the association between patient and laboratory characteristics and ALB screening. Sex, race and age categories, ethnicity, BMI, blood pressure status, HbA1c status, lipid subcategory, eGFR statuses, insulin and oral hypoglycemic medication use, use of ACEi/ARB blockers, service area, and household income were adjusted for. For 2020 and 2021, there were 6,425 (31.6%) and 8,046 (35.8%) individuals missing information on the covariates, respectively. To control for missingness in our regression analyses, we used a complete case analysis approach.[16] SAS Enterprise Guide, Version 8.2 (SAS Institute, Cary, NC), was used to conduct all statistical analyses, with statistical significance assessed at α=0.05.

RESULTS

In the 2020 cohort, there were 20,346 participants with Type 2 diabetes mellitus in the KPGA diabetes registry (Table 1). There were slightly more women than men, a high proportion of African Americans, and a small percentage of Hispanic members. Most participants were aged 18−64 years. Two thirds of the participants were obese, and 20% had blood pressure >140/90 mmHg, whether treated or untreated for hypertension. Most participants had HbA1c levels <9%, and most were taking lipid-lowering (statin) and oral diabetic medications. Approximately 82% were taking ACEi or ARB medications. Only one quarter of the participants was using insulin. There were 22,487 eligible adults with Type 2 diabetes in 2021 with similar participant characteristics.

For both the 2020 and 2021 cohorts, approximately 79% of eligible adults were screened for ALB. Small but statistically significant demographic differences between members who were and were not screened for ALB included differences by race (Asian members were more

Table 1. Characteristics of the 2 Kaiser Permanente of Georgia Diabetic Cohorts Categorized by Albuminuria Screening

	Eligible adult population in 2020 (*n*=20,346)				Eligible adult population in 2021 (*n*=22,487)			
Characteristic	**Percentage of the total cohort**	**Screened, % (*n*=16,033)**	**Not screened, % (*n*=4,313)**	***p*-value**	**Percentage of the total cohort**	**Screened, % (*n*=17,652)**	**Not screened, % (*n*=4,835)**	***p*-value**
Total cohort	100.0	78.8	21.2		100	78.5	21.5	
Patient demographics								
Sex				0.08				0.01
Female	53.0	78.3	21.7		52.6	79.2	20.8	
Male	47.0	79.3	20.7		47.4	77.8	22.2	
Race				<0.001				<0.001
Asian	4.8	81.8	18.2		4.9	81.1	18.9	
African American	58.5	78.9	21.1		58.7	78.0	22.0	
White	27.8	79.2	20.8		6.9	72.6	27.4	
Unknown	6.7	73.7	26.4		2.4	82.4	17.6	
Other	2.3	78.5	21.5		27.2	80.3	19.7	
Service area				<0.001				0.01
East	28.0	79.7	20.4		28.0	80.1	19.9	
South	40.0	77.1	22.9		1.7	76.9	23.1	
West	33.4	80.1	19.9		37.3	77.5	22.5	
Other	1.6	75.9	24.1		33.0	78.4	21.6	
Hispanic				0.15				0.01
Yes	3.3	76.5	23.5		3.7	75.3	24.7	
No	96.7	78.9	21.1		96.3	78.6	21.4	
Age, years				<0.001				<0.001
18–64	60.3	76.6	23.4		60.3	76.2	23.8	
65–74	29.5	82.0	18.0		29.3	81.7	18.3	
75–85	10.2	82.6	17.5		10.4	83.1	16.9	
Patient clinical characteristics								
BMI, kg/m^2				0.06				0.01
<18.5	0.3	73.7	26.3		0.3	74.1	25.9	
18.5–25.0	9.0	79.7	20.3		8.9	82.5	17.5	
25.1–29.9	24.8	80.8	19.2		25.4	79.5	20.5	
≥30.0	66.0	79.1	20.9		65.4	79.3	20.7	
BP, mm Hg				<0.001				<0.001
<140/90	81.0	80.1	19.9		78.4	80.7	19.3	
≥140/90	19.0	76.9	23.1		21.6	75.3	24.7	
HbA1c, %, mean (95% CI)		7.52 (7.5, 7.6)	7.69 (7.62, 7.76)	<0.001	7.58 (7.56, 7.60)	7.52 (7.5, 7.6)	7.69 (7.62, 7.76)	<0.001
HbA1c, %				<0.001				<0.001
<7	44.1	79.7	20.3		42.9	79.8	20.2	
7–9	40.2	81.5	18.5		41.4	81.9	18.1	
≥9%	15.7	75.7	24.3		15.7	74.2	25.9	

(*continued on next page*)

Table 1. Characteristics of the 2 Kaiser Permanente of Georgia Diabetic Cohorts Categorized by Albuminuria Screening (*continued*)

	Eligible adult population in 2020 (*n*=20,346)				Eligible adult population in 2021 (*n*=22,487)			
Characteristic	**Percentage of the total cohort**	**Screened, % (*n*=16,033)**	**Not screened, % (*n*=4,313)**	***p*-value**	**Percentage of the total cohort**	**Screened, % (*n*=17,652)**	**Not screened, % (*n*=4,835)**	***p*-value**
Creatinine, mg/dL, mean (95% CI)	1.0 (0.99, 1.01)	1.01 (1.00, 1.01)	0.98 (0.97, 0.99)	<0.001	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)	0.98 (0.97, 0.99)	0.005
eGFR, mL/min/1.73 m^2, mean (95% CI)	79.7 (79.3, 80.0)	79.4 (79.1, 79.8)	81.22 (80.4, 82.1)	0.01	80.7 (80.4, 81.0)	80.4 (80.1, 80.7)	82.5 (81.7, 83.2)	<0.0001
Total cholesterol, mg/dL, mean (95% CI)	163.6 (162.7, 164.4)	162.3 (161.4, 163.2)	171.9 (169.4, 174.3)	<0.001	161.5 (160.8, 162.2)	160.4 (159.6, 161.2)	168.6 (166.6, 170.7)	<0.0001
LDL cholesterol, mg/dL, mean (95% CI)	95.0 (94.1, 95.9)	93.7 (92.8, 94.6)	104.6 (101.8, 107.3)	<0.001	94.7 (93.9, 95.5)	93.6 (92.7, 94.5)	101.4 (99.0, 103.8)	<0.0001
HDL cholesterol, mg/dL, mean (95% CI)	46.7 (46.4, 46.9)	46.6 (46.4, 46.9)	46.8 (46.2, 47.4)	0.66	47.8 (47.6, 48.0)	47.8 (47.6, 48.0)	47.7 (47.1, 48.3)	0.87
Triglycerides, mg/dL, mean (95% CI)	156.0 (151.2, 160.8)	155.9 (150.6, 161.2)	156.6 (146.3, 166.8)	0.91	145.7 (142.6, 148.8)	145.3 (141.9, 148.7)	148.5 (140.4, 156.6)	0.47
ALB, mg albumin/g creatinine, mean (95% CI)	11.0 (10.4, 11.6)	11.2 (10.6, 11.8)	8.7 (6.8, 10.6)	0.01	11.4 (10.4, 12.3)	11.2 (10.2, 12.2)	13.9 (11.2, 16.7)	0.06
Patient medication use								
Statin use				<0.001				<0.001
Yes	74.9	82.0	18.0		76.0	82.2	17.9	
No	25.1	72.0	28.0		24.0	71.1	28.9	
Oral hypoglycemic agent use				<0.001				<0.001
Yes	73.6	80.6	19.4		74.2	80.7	19.3	
No	26.4	76.5	23.5		25.8	76.2	23.8	
Insulin use				<0.001				<0.001
Yes	27.3	82.2	17.8		25.9	82.1	18.0	
No	72.7	78.5	21.5		74.1	78.6	21.4	
Use of ACEi				<0.001				<0.001
Yes	36.1	81.9	18.1		34.8	81.3	18.7	
No	63.9	78.1	21.9		65.2	78.6	21.4	
Use of ARB				<0.001				<0.001
Yes	26.9	82.3	17.7		28.0	82.1	17.9	
No	73.1	78.5	21.5		72.0	78.5	21.5	
Neighborhood-level factors								
Household income, $	—	—	—		69,701 (69,314, 70,088)	70,379 (69,939, 70,820)	67,221 (66,416, 68,026)	<0.001
Neighborhood Deprivation Index	-—	—	—		0.159 (0.147, 0.170)	0.141 (0.129, 0.155)	0.222 (0.197, 0.247)	<0.001

ACEi, angiotensin-converting enzyme inhibitor; ALB, albuminuria; ARB, angiotensin receptor blocker; BP, blood pressure; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

likely to be screened than members of other races in both 2020 and 2021, with some variances in screening among other races by year), age (participants aged ≥65 years were more likely to be screened than those aged <65 years in both years), and service area (higher screening in east and west service areas than in south and others) (Table 1). There were also statistically significant differences in laboratory outcomes between those who were screened and those who were not screened (Table 2). Those screened for ALB had lower eGFR, total and LDL cholesterol, HbA1c, and blood pressure levels than adults who were not screened. Most differences were small. There were no significant differences between the groups regarding HDL cholesterol and triglyceride levels.

These measures were essentially the same in 2020 and 2021. Additional information available in 2021 showed no differences in travel time to the medical facility where care was provided for those who were and were not screened. The Neighborhood Deprivation Index and the mean family income were significantly higher and lower, respectively, in those who were not screened for ALB than in those who were screened.

Adjusted logistic regression analyses of factors independently associated with ALB screening are shown in Table 2. In the 2020 cohort, African American members (OR=1.18; 95% CI=1.06, 1.32) and adults aged 65−74 years (OR=1.12; 95% CI=1.00, 1.25) had higher odds of having ALB screening than White members or members aged 18−64 years, respectively. Participants with elevated HbA1c (OR=0.79; 95% CI=0.69, 0.91) or blood pressure (OR=0.88; 95% CI=0.79, 0.99) had lower odds of completing ALB screening than the members with acceptable HbA1c and blood pressure ranges. Adults taking statins (OR=1.38; 95% CI=1.24, 1.53), oral hypoglycemic agents (OR=1.22; 95% CI=1.10, 1.35), ACEis (OR=1.72; 95% CI=1.05, 1.30), or ARBs (OR=1.15; 95% CI=1.03, 1.30) had higher odds of completing ALB screening than individuals not taking these medications. In the 2021 cohort, we found no difference in ALB screening by race. Similar to the 2020 cohort, we found that members within the 2021 cohort with elevated blood pressure (OR=0.75; 95% CI=0.68, 0.84) were less likely to be screened, whereas members taking statins (OR=1.29; 95% CI=1.10, 1.43), oral hypoglycemic agents (OR=1.24; 95% CI=1.11, 1.38), or ARBs (OR=1.13; 95% CI=1.01, 1.26) were more likely to complete ALB screening. In this model, higher household income was significantly associated with ALB screening than low household income; members residing in a census tract area with middle (OR=1.19; 95% CI=0.80, 1.76) and high (OR=1.19; 95% CI=1.01, 1.21) income had higher odds of completing screening.

DISCUSSION

There are several important outcomes in this study of urine albumin screening among people with Type 2 diabetes mellitus who were members of an integrated healthcare delivery system. First, we found that it is possible to achieve consistent screening rates of approximately 80% across 2 years, a rate far higher than previously reported from claims data studies and nonintegrated healthcare systems in the U.S. The 80% screening rate is impressive given the COVID-19 pandemic at the time of the study. Second, screening was largely equally distributed and varied little by sex, ethnicity, age, type of diabetes treatment, or part of the metropolitan Atlanta service area where the patients received medical care. Finally, participants who received ALB screening had lower HbA1c levels, a higher proportion of blood pressure control, and lower total and LDL cholesterol levels than individuals who did not receive urine screening. As such, ALB screening seems to be a bellwether of proper, evidence-based diabetes control.

The results of this study are encouraging in 3 other respects. DKD disproportionately affects African American and Hispanic adults and those aged >64 years.[17−20] In this study, African American adults made up twice as many of the population with diabetes as White adults, even though the distribution of African American adults and White adults in KPGA is roughly equal, reflective of the general Atlanta population. Our study reported that African American individuals had higher odds of being screened for ALB in 2020 than White members, and there was no difference in ALB screening between member races for the 2021 cohort. If African Americans and older adults are given equal access to medical care and preventive care, the number of patients developing advanced DKD could decline. Second, the population on which we report had relatively early diabetes, given the low proportion of insulin use and the normal mean creatine levels. ALB levels were low as well. This is the population that should be screened for preventive care. Finally, the rate of RAAS blockade use in this study was higher than that reported from a recent claims data set of patients with chronic kidney disease in the U.S.[21]

Screening for ALB in the Veterans Affairs integrated healthcare system was reported to be ∼50%, lower than what we reported.[22] Outside of the U.S., screening rates are variable. Spain,[23] Norway,[24] and the United Kingdom[25] reported low levels of screening (≤32% screening). In smaller countries, with centralized medical delivery systems, for example, Denmark[26] and South Korea,[27] screening rates have reached ∼80% in the past few years. Regarding automated laboratory ordering, little information is available in the medical literature. In a

Table 2. Factors Independently Associated With Screening for Albuminuria in Kaiser Permanente of Georgia

	Eligible adult population in 2020 included in the final logistic regression model (*n*=13,921)		Eligible adult population in 2021 included in the final logistic regression model (*n*=14,441)	
Effect	**OR**	**95% CI**	**OR**	**95% CI**
Sex: female versus male	0.99	0.90, 1.09	1.17	1.07, 1.28
Race				
Asian/Pacific Islander versus White	1.15	0.91, 1.47	1.12	0.89, 1.41
African American versus White	**1.18**	**1.06, 1.32**	0.99	0.89, 1.10
Other versus White	1.04	0.81, 1.33	1.24	0.90, 1.70
Declined/unknown			0.71	0.56, 0.90
Age, years				
65–74 versus 18–64	**1.12**	**1.00, 1.25**	**1.20**	**1.08, 1.34**
75–85 years versus 18–64 years	**1.19**	**1.00, 1.43**	1.16	0.98, 1.37
Ethnicity: Hispanic versus non-Hispanic	0.95	0.69, 1.32	1.11	0.82, 1.51
BMI category (kg/m^2)				
Obese versus normal	1.17	0.99, 1.37	0.96	0.81, 1.13
Overweight versus normal	**1.20**	**1.02, 1.42**	0.87	0.73, 1.03
Underweight versus normal	0.96	0.43, 2.14	0.24	0.24, 1.38
Blood pressure status: ≥140/90 versus <140/90	**0.88**	**0.79, 0.99**	**0.75**	**0.68, 0.84**
HbA1c category, %				
7–9 versus <7	1.02	0.92, 1.13	0.96	0.87, 1.07
>9 versus <7	**0.79**	**0.69, 0.91**	**0.77**	**0.67, 0.88**
Albuminuria category:				
30-299 vs <30 mg/g	**1.24**	**1.01, 1.52**	1.03	0.85, 1.25
>300 vs <30 mg/g	1.42	0.72, 2.81	0.85	0.49, 1.46
LDL cholesterol category				
Near optimal versus normal	**0.85**	**0.76, 0.95**	0.91	0.82, 1.02
Borderline high versus normal	**0.73**	**0.64, 0.84**	0.87	0.76, 1.00
High versus normal	**0.73**	**0.60, 0.89**	**0.78**	**0.64, 0.96**
Very high versus normal	0.75	0.56, 1.00	0.88	0.63, 1.22
HDL cholesterol category				
High risk versus normal	1.02	0.92, 1.13	0.98	0.88, 1.08
Optimal versus normal	0.92	0.79, 1.06	0.94	0.81, 1.08
eGFR category, mL/min/1.73 m^2				
Mildly decreased versus normal	1.07	0.97, 1.18	1.06	0.96, 1.17
Moderately decreased versus normal	**1.30**	**1.11, 1.52**	**1.27**	**1.09, 1.48**
Severely decreased versus normal	1.11	0.70, 1.78	**1.80**	**1.09, 2.98**
Kidney failure versus normal	NA[a]	NA[a]	1.28	0.15, 10.83
Statin use: yes versus no	**1.38**	**1.24, 1.53**	**1.29**	**1.1, 1.43**
Oral hypoglycemic agent use: yes versus no	**1.22**	**1.10, 1.35**	**1.24**	**1.11, 1.37**
Insulin use: yes versus no	1.07	0.96, 1.20	**1.23**	**1.11, 1.38**
ACEi use: yes versus no	**1.17**	**1.05, 1.30**	1.09	0.98, 1.21
ARB use: yes versus no	**1.15**	**1.03, 1.30**	**1.13**	**1.01, 1.26**
Service area				
East versus south	**1.14**	**1.01, 1.28**	1.10	0.98, 1.24
West versus south	1.11	0.99, 1.24	1.03	0.93, 1.15
Other versus south	1.07	0.77, 1.50	0.98	0.72, 1.35
Household income				
Middle income versus low income			1.19	0.80, 1.76
High income versus low income			**1.11**	**1.01, 1.21**

Note: Bolded results are statistically significant.
ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NA, not available.
[a]An OR and 95% CI were not calculated owing to a small sample size within this eGFR category.

study from Spain, spot urinary albumin-to-creatinine ratios were electronically ordered in patients with diabetes when not ordered according to guidelines. There was a 6.2% increase in the screening rate.[28]

Despite our encouraging results, ~20% of the KPGA diabetic cohort did not complete at least 1 ALB screening in either 2020 or 2021. Although no system is perfect, not screening ~20% of people at risk for DKD is a missed opportunity with significant financial and social implications. Data for this study were accumulated during the COVID-19 pandemic, and it is likely that many participants under health plan avoided coming to their physician or the medical office. In addition, lower income and higher deprivation distress were associated with less ALB screening. Socioeconomic factors often impede the delivery of health care even when available.[29]

Limitations

This study has several limitations. First, this was an observational study. We did not demonstrate whether ALB testing directly improved clinical practices; we only demonstrated associations. Second, our analyses were limited to an integrated healthcare system in which data were available to all physicians caring for its members. A high degree of coordinated care was available, which is generally not available in the U.S. healthcare system. Third, we had a high percentage (>20%) of missing covariate information in our data and decided to use complete case analysis instead of inverse probability weighting or multiple imputation, under the assumption that the information was missing at random. Finally, we could not parse out the effects of automatic ALB ordering, the effects of panel management, and individual prescribers for ordering ALB tests.

CONCLUSIONS

Our observational findings suggest that in an integrated, coordinated healthcare system, measures that leverage technology and improve participant knowledge of diabetes can improve ALB screening. A recent simulation study suggests that ALB screening can lead to lower end-stage renal disease rates and is cost effective.[30] The measures reported in this paper can help close the gap for ALB testing[31] and are not expensive to implement relative to the cost of treating progressive DKD. What is more, these measures seem to increase the representativeness of those screened and to improve diabetes care.

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