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Disruption to routine diabetes care processes during the pandemic: evidence from a large integrated health system in the Southeast United States

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ABSTRACT

Introduction We investigated the impact of the COVID-19 pandemic on annual adherence to seven diabetes care guidelines and risk factor management among people with diabetes.

Research design and methods We included all adults (aged ≥18 years) with prevalent diabetes as of 1 January 2018, who were continuously enrolled at Kaiser Permanente Georgia (KPGA) through 31 December 2021 (n=22 854). Prevalent diabetes was defined as a history of at least one of a diagnosis code for diabetes, use of antihyperglycemic medication, or at least one laboratory value of HbA1c, fasting plasma glucose or random glucose in the diabetic range. We defined pre-COVID (2018–2019) and during COVID (2020–2021) cohorts. Cohort-specific laboratory measurements (ie, blood pressure (BP), HbA1c, cholesterol, creatinine, urine-albumin-creatinine ratio (UACR)) and procedures (ie, eye and foot examinations) were determined from KPGA's electronic medical record data. We used logistic generalized estimating equations (GEE), adjusted for baseline age, to assess the within-subject change in guideline adherence (ie, at least one measurement per year per period) from pre-COVID to during COVID era overall, and by age, sex, and race. Linear GEE compared mean laboratory measurements pre and during COVID.

Results The proportion of adults meeting each of the seven diabetes care guidelines decreased significantly during (vs pre) COVID (range in absolute reductions: −0.8% to −11.2%) with greatest reductions seen for BP (−11.2%) and cholesterol (−8.8%). Declines were similar across age, sex, and race subgroups. Average HbA1c and systolic BP increased 0.11% and 1.6 mmHg, respectively, while low-density lipoprotein cholesterol declined 8.9 mg/dL. The proportion of adults at high risk of kidney disease (ie, UACR ≥300 mg/g) increased from 6.5% to 9.4%.

Conclusions In an integrated healthcare system, the proportion of people with diabetes meeting guideline-recommended screenings decreased during the pandemic, coinciding with worsening glucose, kidney, and (some) cardiovascular risk profiles. Follow-up is needed to assess the long-term implications of these care gaps.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The COVID-19 pandemic disrupted access to routine healthcare services, yet the extent to which the pandemic impacted adherence to recommended annual screenings and risk factor management among people with diabetes is less clear.

WHAT THIS STUDY ADDS

⇒ In this study, we show that adherence to guideline-recommended screenings among people with diabetes in a managed care setting was significantly disrupted during the COVID-19 pandemic, despite relatively uniform healthcare access for this group. This disruption was largely similar across race, age, and sex groups. Our data also suggest that these disruptions may have led to worsening glucose, kidney, and (some) cardiovascular risk profiles.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ As we move into a postpandemic world, understanding the long-term implications of these care gaps will be important for the ongoing management of people with diabetes.

INTRODUCTION

The COVID-19 pandemic disrupted access to routine healthcare services.[1] People with diabetes frequently require routine medical care, such as regular glucose monitoring and prescription refills, and have faced significant disruptions to care. Indeed, a December 2020 study by the American Diabetes Association (ADA) found that 43% of people with diabetes delayed seeking routine medical care during the pandemic.[2]

Current ADA guidelines recommend annual screening for blood pressure (BP), HbA1c, cholesterol, creatinine, urine-albumin-creatinine ratio (UACR), and eye and foot examinations[3] to identify early signs of diabetes-related complications and implement early treatments to reduce ophthalmological (leading to blindness), neurological (leading to amputation), and cardiovascular and chronic kidney diseases.[3] The extent to

which the COVID-19 pandemic impacted adherence to recommended annual screenings within an integrated care setting, and whether this impact was uniform across population subgroups, is unknown.

Our primary aim was to investigate the impact of the COVID-19 pandemic on adherence to seven recommended annual diabetes screenings among people with diabetes overall, and by age, sex, and race subgroups. In a secondary aim, we investigated the impact of the COVID-19 pandemic on average laboratory measurements for five of the diabetes screenings.

RESEARCH DESIGN AND METHODS

Data source

Kaiser Permanente Georgia (KPGA) is a large health insurance database of more than 260 000 current adult members (>40% Black) across 2230 US census tracts in the metropolitan Atlanta area as well as North Georgia. KPGA has an extensive data repository of electronic medical records (EMR), including information related to patient demographics, diagnoses, procedures, claims, laboratory values, and prescribed medications.

Study population

We identified all adult (≥18 years) members of KPGA with prevalent diabetes as of 1 January 2018 (n=38 072). Prevalent diabetes was defined as a history of at least one of a diagnosis code for diabetes (International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 249 and 250 prior to October 2015, and ICD-10-CM codes E08–E13 from October 2015 onward), use of antihyperglycemic medication, or at least one laboratory value of HbA1c ≥6.5%, fasting plasma glucose ≥126 dg/mL or random glucose ≥200 dg/mL. We did not differentiate between type 1 and type 2 diabetes, but as 95% of people with diabetes have type 2,[4] results of this study are broadly applicable to people with type 2 diabetes. We excluded anyone who died during the follow-up period (n=2161; 5.6%) or discontinued KPGA enrollment (n=13 057; 34.1%). Characteristics of those included versus not included are found in online supplemental table 1. Not included patients were generally similar to included patients but were, on average, younger (55.9 years) than included (59.4 years) members and less likely to be Black (49.9% vs 57.4%). Our final sample size included 22 854 adult KPGA members with diabetes and continuous enrollment from January 2018 to December 2021. Prepandemic period was defined from 1 January 2018 through 31 December 2019, and during pandemic period was defined from 1 January 2020 through 31 December 2021. A waiver of informed consent was approved for use of these deidentified data.

Data and resource availability

The data that support the findings of this study are available from KPGA but restrictions apply to the availability of these data, which were used under license for the current study and therefore are not publicly available. Data are, however, available from the authors on reasonable request and with permission of KPGA.

Diabetes care processes and measurements

We examined seven annual diabetes care processes within KPGA members' EMR between 2018 and 2021 (table 1). We categorized people as meeting or not meeting each of the recommended annual screenings within the pre-COVID and during COVID periods if they had at least one screening per year (ie, two per period). We also compared the average values for measurements of BP, HbA1c, creatinine, UACR, and total cholesterol in the pre-COVID and during COVID periods, whereby the

Table 1 Definition of seven annual diabetes care processes

Diabetes care process	Definition	Guidelines[3]
Blood pressure (BP)	At least one recorded value for systolic or diastolic BP per year	<130/80 mm Hg
HbA1c	At least one recorded value for HbA1c per year	<7.0%
Cholesterol	At least one recorded value for cholesterol per year	LDL<100 mg/dL
Creatinine	At least one recorded value for creatinine per year	Used to estimate eGFR*
Urine-albumin-creatinine ratio (UACR)	At least one recorded value for UACR per year	<30 mg/g
Eye examination†	At least one procedure code record for eye examination per year	n/a
Foot examination‡	At least one procedure code record for foot examination per year	n/a

*There are no guideline-specific cut-offs for creatinine. Instead, in combination with other factors such as age, sex and body surface area, creatinine is used to determine the estimated glomerular filtration rate (eGFR). The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation is preferred. eGFR is not reported here.
†CPT codes: 92002, 92004, 92012, 92014, 92015, 99172 and 99173.
‡CPT codes: G0245, G0246, G0247, G9226, 11055, 11056, 11057, 11719, 11720, 11721, S0390
CPT, Current Procedural Terminology; LDL, low-density lipoprotein.

average was the sum of all laboratory results, divided by the total number of laboratory measurements recorded.

Covariates

Characteristics of the study population, including comorbidities, were ascertained from KPGA's EMR. Comorbidities were defined using the Elixhauser Comorbidity Index of ICD-9 and ICD-10 codes and represent prevalent conditions as of 1 January 2018. In particular, retinopathy was defined as diabetes with ophthalmic complications, and neuropathy was defined as diabetes with neurological conditions or a history of non-traumatic amputation. Neighborhood-level median household income and the Social Vulnerability Index were ascertained using US census tract data. Race was defined as White, Black or other where 'other' is made up of Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, Asian, or multiple races. For those missing self-reported race data (n=1106; 4.8%), we applied a Bayesian method integrating surname and geocoded information to impute self-reported race.[5] This approach has previously shown high correlation (76%) with self-reported race with other KP databases.[5] For all variables, <0.5% of data were missing.

Statistical analysis

We followed all individuals in this longitudinal cohort from 1 January 2018 until 31 December 2021. Characteristics of the study population were summarized with frequencies, proportions, means and medians as appropriate. To compare diabetes care pre (2018–2019) and during (2020–2021) the pandemic, we summarized the proportion of people meeting recommended screenings in both periods, and examined the absolute change over time, defined as the proportion meeting guidelines during the pandemic minus the proportion meeting guidelines prepandemic. To assess the within-subject change in guideline adherence from pre-COVID to during COVID period, we performed logistic generalized estimating equation (GEE) regressions, adjusted for baseline age, for each diabetes care process. We report ORs overall and stratified by baseline age (<50 and ≥50 years), sex (men and women) and race (Black, White, other). Of note, as the same individuals were included in pre-COVID and during COVID periods, we did not adjust for race, sex, or comorbidities which were only ascertained at baseline.

To compare mean laboratory measurements pre (2018–2019) and during (2020–2021) the pandemic among those with measurements available, we similarly examined the absolute change over time, and performed linear GEE regressions, adjusted for baseline age, for each measurement of BP, HbA1c, creatinine, and total cholesterol. For UACR, data were highly skewed and thus we compared the proportion of adults at high risk for kidney disease (ie, UACR ≥300 g/mg) and reported ORs. Laboratory measurements were examined overall and stratified by people meeting annual guidelines (or not).

Sensitivity analyses

In sensitivity analyses, we examined changes in adherence to recommended screenings among those without prevalent congestive heart failure (CHF), retinopathy, or neuropathy (n=12 347), and applying a looser definition of meeting screening guidelines (ie, at least one care process in each 2-year period).

Table 2 Baseline characteristics of adult KPGA members with diabetes as of 1 January 2018

Characteristic	Value
n	22 854
Demographics	
Age (years, mean (SD))	59.4 (13.0)
Men (%)	44.5
Race (%)	
White	32.6
Black	57.4
Other	10.0
Social Vulnerability Index (%)	
Quartile 1 (low vulnerability)	22.8
Quartile 2	28.6
Quartile 3	27.3
Quartile 4 (high vulnerability)	21.3
Household income (US$; %)	70 300 (27 300)
≤50 000	24.0
50 001–100 000	64.1
100 001–150 000	10.1
>150 000	1.9
Healthcare access (%)	
Flu shot in 2018	68.6
Wellness visit in 2018	66.4
Comorbidities	
Body mass index, kg/m^2 (mean (SD))	33.1 (7.15)
BMI (%)	
Not obese (<30 kg/m^2)	37.0
Obese (≥30 kg/m^2)	62.6
Smoker (%)	10.7
Hypertension (%)	81.7
Depression (%)	29.4
Chronic lung disease (%)	36.5
Renal failure (%)	20.2
Congestive heart failure (%)	12.9
Peripheral vascular disease (%)	26.8
Retinopathy (%)	31.6
Neuropathy (%)	22.5

BMI, body mass index; KPGA, Kaiser Permanente Georgia.

Table 3 Logistic GEE regression comparing odds of meeting annual diabetes care guidelines in pre versus during pandemic period among KPGA adult members with prevalent diabetes, 2018–2021

	% meeting annual guidelines			
Diabetes care process	Prepandemic (2018–2019)	During pandemic (2020–2021)	Absolute change (during vs pre)	OR (95% CI)*
HbA1c	79.0	75.1	−3.9	0.80 (0.76 to 0.83)
Blood pressure	93.5	82.3	−11.2	0.31 (0.29 to 0.33)
Cholesterol	38.7	29.9	−8.8	0.67 (0.65 to 0.70)
Creatinine	77.1	75.2	−1.9	0.90 (0.86 to 0.94)
UACR	35.3	31.5	−3.8	0.84 (0.81 to 0.88)
Eye examination	14.3	11.0	−3.3	0.72 (0.68 to 0.76)
Foot examination	2.7	1.9	−0.8	0.67 (0.60 to 0.76)

*Compares during versus pre period, adjusted for baseline age.
GEE, generalized estimating equation; KPGA, Kaiser Permanente Georgia; UACR, urine-albumin-creatinine ratio.

RESULTS

Among the 22 854 KPGA adult members with prevalent diabetes who were continuously enrolled between 2018 and 2021, mean age in 2018 was 59.4 (±13.0), 44.5% were men, and 57.4% were Black (table 2). More than 60% of people had obesity, most (81.7%) had hypertension, and a large proportion had a history of depression (29.4%) and chronic lung disease (36.5%). Further, 12.9%, 31.6%, and 22.5% of KPGA members had prevalent CHF, retinopathy, and neuropathy, respectively, at baseline.

Prepandemic, 79%, 93.5%, 38.7%, 77.1%, 35.3%, 14.3% and 2.7% of people met annual checks for HbA1c, BP, cholesterol, creatinine, UACR, eye, and foot screening, respectively. During COVID-19, the proportion of people meeting annual guidelines declined across all diabetes care processes (range in absolute declines: −0.8% to −11.2%), with greatest absolute reductions seen for BP (−11.2%) and cholesterol (−8.8%) measurements. Relative declines, adjusted for age, were greatest for BP measurements (OR 0.31, 95% CI 0.29–0.33), cholesterol (OR 0.67, 95% CI 0.65–9.70), and foot examinations (OR 0.67, 95% CI 0.60–0.76) (table 3).

Declines in meeting annual screening guidelines were broadly similar across ages, sexes, and races, with some exceptions (table 4). First, absolute declines in BP measurement were greater in younger (<50 years) versus older (≥50 years) KPGA members, while declines in creatinine and foot examinations were greater in older versus younger members. Second, absolute declines in BP measurement were greater in men, while declines in creatinine were greater in women. Third, absolute declines in BP, HbA1c and cholesterol measurement were greatest in 'other' race groups as compared with both Black and White KPGA members.

During COVID-19, and among those for whom measurements were taken, average increases were seen for HbA1c and BP, while low-density lipoprotein (LDL) cholesterol decreased, and creatinine remained similar. For UACR, the proportion of KPGA adults at high risk for kidney disease increased significantly (table 5). Similar patterns were seen in people who did or did not meet annual guidelines in pre-COVID-19 and during COVID-19 periods with some exceptions: for people not meeting annual guidelines, there was a greater increase in HbA1c (0.35%) as compared with people meeting guidelines (0.12%), but smaller declines in BP, LDL, and UACR (online supplemental table 2).

Sensitivity analyses

Loosening our definition of 'meeting guidelines' from one screening per year to one per 2-year period resulted in a higher proportion of KPGA members meeting guidelines in both prepandemic and during pandemic periods (online supplemental table 3). Absolute declines were smaller (vs stricter guideline definition) but patterns were largely similar with some exceptions—greatest declines were seen for cholesterol and UACR, and there was a small 1% increase in the proportion of KPGA members having creatinine measured during (vs pre) pandemic period. These patterns were similar across age, sex, and race groups (online supplemental table 4).

When restricting to people without prevalent CHF, retinopathy, or neuropathy, patterns were similar to findings in the total population with greatest absolute declines seen for BP (14.2%) and cholesterol (9.8%) (online supplemental table 5). Results were similar by age, sex, and race (online supplemental table 6).

CONCLUSIONS

Adherence to guideline-recommended screenings among people with diabetes in a managed care setting was significantly disrupted during the COVID-19 pandemic, despite relatively uniform healthcare access for this group. This disruption was largely similar across race, age, and sex groups. Our data also suggest that these disruptions may have led to worsening glucose, kidney, and (some) cardiovascular risk profiles, though more research is needed to confirm these findings.

Table 4 Logistic GEE regression comparing odds of meeting annual diabetes care guidelines in pre versus during pandemic period among KPGA adult members with prevalent diabetes, 2018–2021, stratified by age, sex, and race

	% meeting annual guidelines			
Diabetes care process	**Prepandemic (2018–2019)**	**During pandemic (2020–2021)**	**Absolute change (during vs pre)**	**OR (95% CI)***
By age				
<50 years				
HbA1c	64.2	60.5	−3.7	0.84 (0.78, 0.91)
Blood pressure	88.6	73.4	−15.2	0.30 (0.27, 0.34)
Cholesterol	30.8	21.8	−9.0	0.63 (0.57, 0.68)
Creatinine	57.9	59.4	1.5	1.06 (0.98, 1.15)
UACR	24.7	21.1	−3.6	0.82 (0.74, 0.89)
Eye examination	2.6	2.4	−0.2	0.93 (0.73, 1.19)
Foot examination	0.3	0.2	−0.1	0.56 (0.25, 1.27)
≥50 years				
HbA1c	83.2	79.3	−3.9	0.79 (0.74, 0.83)
Blood pressure	94.9	84.9	−10.0	0.33 (0.30, 0.36)
Cholesterol	41.0	32.2	−8.8	0.68 (0.66, 0.71)
Creatinine	82.6	79.8	−2.8	0.83 (0.79, 0.88)
UACR	38.3	34.5	−3.8	0.85 (0.81, 0.89)
Eye exam	17.6	13.5	−4.1	0.73 (0.69, 0.77)
Foot examination	3.4	2.4	−1.0	0.68 (0.60, 0.77)
By sex				
Women				
HbA1c	77.3	73.4	−3.9	0.80 (0.75, 0.85)
Blood pressure	94.9	84.1	−10.8	0.28 (0.25, 0.30)
Cholesterol	37.2	28.5	−8.7	0.67 (0.64, 0.71)
Creatinine	77.0	74.1	−2.9	0.85 (0.80, 0.90)
UACR	31.6	28.1	−3.5	0.84 (0.80, 0.89)
Eye examination	14.1	11.1	−3.0	0.74 (0.69, 0.80)
Foot examination	2.3	1.5	−0.8	0.62 (0.52, 0.75)
Men				
HbA1c	81.0	77.2	−3.8	0.79 (0.74, 0.85)
Blood pressure	91.7	80.0	−11.7	0.34 (0.32, 0.38)
Cholesterol	40.6	31.6	−9.0	0.67 (0.64, 0.71)
Creatinine	77.3	76.6	−0.7	0.96 (0.90, 1.03)
UACR	39.8	35.8	−4.0	0.84 (0.80, 0.89)
Eye examination	14.5	10.9	−3.6	0.70 (0.64, 0.76)
Foot examination	3.3	2.4	−0.9	0.72 (0.61, 0.85)
By race				
White				
HbA1c	78.2	75.1	−3.1	0.83 (0.77, 0.90)
Blood pressure	94.2	83.7	−10.5	0.30 (0.27, 0.34)
Cholesterol	43.2	33.7	−9.5	0.68 (0.64, 0.71)
Creatinine	79.2	77.0	−2.2	0.87 (0.80, 0.94)
UACR	34.1	29.4	−4.7	0.87 (0.83, 0.92)

Continued

Table 4 Continued

Diabetes care process	% meeting annual guidelines Prepandemic (2018–2019)	During pandemic (2020–2021)	Absolute change (during vs pre)	OR (95% CI)*
Eye examination	16.0	12.5	−3.5	0.73 (0.66, 0.81)
Foot examination	2.3	2.1	−0.2	0.90 (0.72, 1.11)
Black				
HbA1c	79.3	75.1	−4.2	0.78 (0.73, 0.83)
Blood pressure	93.5	82.6	−10.9	0.32 (0.30, 0.35)
Cholesterol	34.4	26.2	−8.2	0.67 (0.62, 0.71)
Creatinine	76.5	74.8	−1.7	0.90 (0.85, 0.96)
UACR	36.3	33.2	−3.1	0.80 (0.75, 0.86)
Eye examination	13.6	10.5	−3.1	0.72 (0.67, 0.78)
Foot examination	3.3	2.0	−1.3	0.60 (0.52, 0.70)
Other				
HbA1c	79.3	75.2	−4.1	0.78 (0.68, 0.90)
Blood pressure	90.9	76.0	−14.9	0.31 (0.26, 0.37)
Cholesterol	48.9	38.7	−10.2	0.66 (0.58, 0.74)
Creatinine	73.7	72.3	−1.4	0.93 (0.81, 1.06)
UACR	33.4	28.5	−4.9	0.79 (0.70, 0.90)
Eye examination	12.5	9.1	−3.4	0.68 (0.56, 0.82)
Foot examination	1.1	0.5	−0.6	0.45 (0.22, 0.93)

*Compares during versus pre period, adjusted for baseline age.
GEE, generalized estimating equation; KPGA, Kaiser Permanente Georgia; UACR, urine-albumin-creatinine ratio.

For HbA1c screening, absolute declines in our study population (3.9%) are smaller than declines reported in another US-based study using Epic Cosmos data (8.3%).[6] This is most likely due to our population being members of an integrated healthcare system that was able to rapidly transition to telehealth care during the pandemic, and also as our study includes longer follow-up time (2 years vs 1 year) during the pandemic (where it is anticipated

Table 5 Linear GEE regression comparing mean diabetes care measurements in pre versus during pandemic period among KPGA adult members with prevalent diabetes, 2018–2021

Diabetes care process	Prepandemic (2018–2019)	During pandemic (2020–2021)	Absolute change (during vs pre)	Mean difference (95% CI)*
HbA1c (mean; %)	7.2 (1.7)	7.4 (1.7)	+0.11	0.13 (0.11, 0.15)
Systolic BP (mean (SD); mm Hg)	132.4 (12.2)	133.9 (12.5)	+1.58	1.22 (1.08, 1.35)
Diastolic BP (mean (SD); mm Hg)	72.4 (8.7)	72.3 (9.2)	−0.09	0.41 (0.32, 0.49)
LDL cholesterol (mean (SD); mg/dL)	101.3 (41.9)	92.4 (36.6)	−8.86	−7.77 (−8.32, −7.23)
Creatinine (mean (SD); mg/dL)	1.1 (0.7)	1.1 (0.8)	+0.02	0.01 (0.00, 0.01)
				OR (95% CI)
UACR (% >300 mg/g)†	6.5	9.4	+2.9	1.47 (1.35,1.60)

Missingness: Prepandemic: HbA1c=6.7%; BP=1.7%; cholesterol=19.0%; creatinine=7.0%; UACR=31.8%. During pandemic: HbA1c=8.2%; BP=13.2%; cholesterol=26.8%; creatinine=6.3%; UACR=39.4%.
*Compares during versus pre period, adjusted for baseline age; a 95% CI that does not include 0 is significant.
†UACR was highly skewed and thus we compared the proportion of those with high risk of kidney disease (UACR>300 mg/g) pre and during the pandemic and reported OR (95% CI) adjusted for baseline age.
BP, blood pressure; GEE, generalized estimating equation; KPGA, Kaiser Permanente Georgia; LDL, low-density lipoprotein; UACR, urine-albumin-creatinine ratio.

that over time, screening practices may return to pre-COVID levels). Other studies have also reported declines in outpatient visits among people with diabetes,[6 7] but no corresponding increase in the incidence of complications requiring acute care,[6] and either none[7] or modest[6] declines in glycemic control. We add to this body of evidence by adding insights regarding completion of individual recommended screenings, as well as examination of differences by age, sex, and race. To that end, we show declines were not uniform across subgroups (or across recommended care processes), with younger (vs older) adults, men (vs women), and other (vs Black and White) races less likely to meet BP measurements, while older (vs younger) adults and women (vs men) were less likely to meet serum creatinine testing. Reasons for these differences are unknown and require further examination.

Our examination of average laboratory measurements suggests that HbA1c, BP, and UACR worsened over time, while LDL cholesterol significantly improved. These data should be interpreted with caution owing to the large proportion of individuals in our population missing recorded laboratory measurements. Nonetheless, our findings of modest declines in glycemic control are similar to a study by Chen *et al*[6] reporting a 0.05 mmol/L increase in HbA1c from January 2019 to February 2021 using Epic Cosmos data. In another US study, using Optum data, Patel *et al*[7] reported nearly identical levels of HbA1c in 2020 compared with 2019 (7.16% vs 7.14%; 0.3%), though this study may not have captured the full impact of the COVID-19 as follow-up ended in 2020. Reasons for the decline in LDL cholesterol in our study are unclear and warrant future investigations. We also demonstrated that worsening risk factor profiles during the course of the pandemic may have been even greater in people who were (vs not) meeting annual guidelines. This suggests that sicker patients may have been those who were most likely to have measurements taken. More complete data, with longer follow-up, are needed to fully elucidate the impact of the COVID-19 pandemic on long-term glucose, cardiovascular, and kidney risk factor profiles. In the interim, use of telemedicine or continuous glucose monitoring might improve glycemic control among people with diabetes who may remain reluctant to interact with the healthcare system to the same levels as before the COVID-19 pandemic.

Our study has several limitations. First, this study includes a highly select population of people with continuous enrollment within an integrated health system who are majority Black and thus results are not generalizable to US adults without health insurance or different demographic populations. Nonetheless, examining this population allows us to examine the impact of the pandemic on healthcare access among a group of people with relatively uniform access to healthcare via health insurance. Second, it is possible that use of CPT codes to capture eye and foot examinations underestimates the proportion of people meeting these screening guidelines. Nonetheless, using CPT codes in both the prepandemic and during pandemic periods allows us to compare care processes over time. Third, analyses of average laboratory measurements over time are limited to those who had a measurement recorded which may overestimate or underestimate true estimates. Further, for some measurements, in particular UACR there is a large proportion of missing data (>30%) and thus results should be interpreted with caution. Fourth, we are unable to account for differences in healthcare policies or individual-level behaviors that may also have changed during the pandemic period and thus possibly confounded our results. Therefore, conclusions of this work pertain to the cumulative effect of the pandemic on diabetes screenings, and not to one element alone. Finally, we did not capture data on weight or smoking status, two other key diabetes screening measurements, at both time points (only prepandemic). Therefore, future research should consider the impact of the pandemic on these factors.

In our study of individuals enrolled in an integrated care setting, the proportion of people with diabetes meeting individual guideline-recommended screenings decreased during the pandemic. This appeared to coincide with worsening glucose, kidney, and some cardiovascular risk factor profiles. As the pandemic persists, continued research and careful monitoring is needed to assess the long-term implications of these care gaps.

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Contributors JLH conceived the study, contributed to study design, oversaw the analysis, and contributed to writing the manuscript. YW conducted all analyses and reviewed/edited the manuscript. JCG and BM contributed to study design and data collection and revised/edited the manuscript. SAO contributed to data analysis and revised/edited the manuscript. MKA contributed to study conceptualization, provided intellectual input and reviewed/edited the manuscript. All authors approved the final version of this manuscript. JLH is the guarantor of this work and takes responsibility for the decision to submit this work.

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Ethics approval This study involves human participants and was approved by the Institutional Review Boards at Emory University (STUDY00002924) and Kaiser Permanente Georgia (IRB 00000406). Only deidentified data were used.

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Data availability statement Data may be obtained from a third party and are not publicly available. The data that support the findings of this study are available from KPGA but restrictions apply to the availability of these data, which were used under license for the current study and therefore are not publicly available.

Data are, however, available from the authors upon reasonable request and with permission of KPGA.

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