

Physician Utilization by Insurance Type Among Youth With Type 2 Diabetes

Carrie McAdam-Marx, PhD; Robert I. Field, PhD; Stephen Metraux, PhD;
Stephen T. Moelter, PhD; and Diana I. Brixner, PhD

Obesity, sedentary lifestyles, and changing racial/ethnic mix have contributed to an increasing prevalence of type 2 diabetes mellitus among youth in the United States, a condition that historically was diagnosed only in adults.¹ Published prevalence estimates vary depending on the population studied and range from 0.35 cases per 1000 in an insured cohort² to 1.5 cases per 1000 in the United States overall.³ The occurrence of type 2 diabetes in youth (a chronic incurable condition) is an important issue with long-term implications. Type 2 diabetes is associated with cardiovascular complications such as heart disease, heart attack, and stroke.^{4,5} When type 2 diabetes develops in youth, these cardiovascular complications may arise as much as 15 years sooner than in their healthy peers.^{6,7} Therefore, the rise in the occurrence of type 2 diabetes among youth may lead to an excess burden on patient health and on the healthcare system in the future.

Effective weight and exercise management in overweight and obese individuals can help to delay or prevent the onset of type 2 diabetes in those progressing toward diabetes.^{8,9} Therefore, access to physician care could facilitate risk assessment, leading to preventive care in youth who show signs of developing type 2 diabetes, as well as create opportunities for early diagnosis and treatment. Thus, barriers to physician care could contribute to prevention, diagnosis, treatment, and outcomes disparities for patients with access issues.

Health insurance status is a factor known to be associated with physician access for individuals of all ages and across many disease states, with access disparities most notable between patients with versus without insurance.¹⁰ In the United States, 88% of youth have health insurance, with more than 25% covered by Medicaid or other public programs.¹¹ However, youth with Medicaid coverage are less likely to use physician services in the course of a year and are less likely to receive needed healthcare services than youth with private insurance,¹² possibly because of related socioeconomic factors such as issues with transportation or inability to identify a provider with service hours that accommodate working parents. It is unknown whether physician utilization disparities continue to exist if Medicaid-covered youth can overcome initial access barriers.

There are long-term health benefits in preventing type 2 diabetes and in early diagnosis and treatment, but it is unknown if reduced access

Objective: To evaluate the relationship between insurance type (Medicaid vs private insurance) and access to physician care for youth with type 2 diabetes mellitus by quantifying whether these youth saw a physician during the year before their first diabetes documentation.

Study Design: Retrospective cohort study.

Methods: Youth with Medicaid or private insurance aged 5 to 19 years with type 2 diabetes were identified by an electronic medical record review. The first indication of type 2 diabetes defined the index date. Youth with type 1 diabetes and female patients with polycystic ovaries were excluded. Descriptive statistics evaluated differences in office visits before the index date between patients with the 2 insurance types. Multivariate logistic regression analysis evaluated the likelihood of having an office visit during the year before the index date among youth with Medicaid versus private insurance, controlling for youth characteristics.

Results: Of 2496 included youth, 400 (16.0%) had Medicaid coverage. More than 60% were female, the mean age was 14.5 years, and 68.8% were obese. On average, youth had 1.9 office visits during the year before the index date. Medicaid-covered youth were not significantly less likely to have had an office visit (odds ratio, 0.77; $P = .09$) or fewer total office visits (incident rate ratio, 1.13; $P = .16$) during the year before the index date.

Conclusions: The likelihood of youth with type 2 diabetes and a source of physician care having a physician office visit during the year before the index date did not differ between patients with Medicaid versus private insurance. This suggests that the amount of physician care before diagnosis of type 2 diabetes does not differ for Medicaid-covered youth if they can establish a source of care. Additional research is investigating whether physician access before diagnosis is associated with access to diabetes-related care after diagnosis.

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Take-Away Points

This study addressed whether physician utilization disparities persist between privately insured youth and Medicaid-covered youth if the latter can overcome initial access barriers.

- When Medicaid-covered youth are able to establish a source of care, utilization of physician services during the year before their first indication of type 2 diabetes is not less than that among privately insured youth.
- Managed Medicaid plans could help to reduce physician access disparities by ensuring adequate network coverage, which may equalize opportunities for screening and preventive care for diabetes and other conditions.

to care before the diagnosis of type 2 diabetes influences the quality of care through factors such as treatment disparities and poor outcomes. Before establishing the implications of access to care, this article first answers the question of whether physician utilization differences exist for Medicaid-covered youth with type 2 diabetes relative to those with private insurance. This study investigates this baseline question by evaluating whether utilization of physician services differs in the year before the first indication of type 2 diabetes (index date). It also considers youth who have initiated a source of physician care as documented in an ambulatory care–based electronic medical record (EMR) and includes young patients who were able to overcome basic access barriers. Ongoing research is investigating the larger question of whether physician access disparities translate into differences in the utilization of diabetes-related care for youth, which begins to broach the issue of quality of care.

METHODS

A retrospective cohort study identified physician office visits for youth aged 5 to 19 years with Medicaid or private insurance in the year before the index date. The time frame examined was from January 1996 through December 2007.

Data Source

The data source for this study was the General Electric Healthcare Centricity EMR (GE EMR) research database.¹³ The GE EMR contains longitudinal ambulatory electronic health data for 8 million patients from January 1996 through December 2007. Patient-level data includes but is not limited to demographic information, vital signs, office visits, laboratory test results, medication histories and prescription orders, and diagnoses.

The research database has been derived from data contributed by more than 6000 ambulatory care–based practitioners in 35 states who use the GE EMR. Approximately two-thirds of these clinicians practice primary care. Data are centrally collected and undergo a quality control process to remove or correct invalid data. The database is deidentified and is

compliant with the Health Information Portability and Accountability Act.

Study Population

The study was based on a subset of GE EMR youth 19 years or younger on their first day of activity in the database. In summary, youth were included from this subset if they had indications of type 2 diabetes in the GE EMR, were aged 5 to 19 years on the date when type 2 diabetes was first documented in the database (defined as the index date), had at least 1 additional interaction with the GE EMR physician that occurred at least 90 days after the index date, and had Medicaid or private insurance. Youth with type 1 diabetes and female patients with polycystic ovaries were excluded.

More specifically, youth were identified as having type 2 diabetes if they met at least 1 of the following indicators: (1) two consecutive fasting blood glucose levels of at least 126 mg/dL (to convert glucose level to millimoles per liter, multiply by 0.0555), (2) two documented *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes for type 2 diabetes (250.X0 and 250.X2), (3) a prescription order or medication list entry for an oral antidiabetic drug, or (4) a prescription order or medication list entry for insulin with at least 1 *ICD-9-CM* diagnosis code for type 2 diabetes.

An index date was assigned to each patient and was the earliest date when a patient met 1 of the diagnosis criteria for type 2 diabetes. Once the index date was established, the sample was limited to youth aged 5 to 19 years on the first date when type 2 diabetes was documented in the GE EMR. This age range was used to capture the onset of puberty, which is associated with the development of type 2 diabetes.¹⁴⁻¹⁶ Exclusion of patients younger than 5 years, an approach used by other studies^{17,18} of type 2 diabetes in children, was incorporated because type 2 diabetes diagnoses among children in this age group are rare.^{19,20}

Subjects were included if they continued to have interaction with the GE EMR physician after the first indication of type 2 diabetes, with the last interaction at least 90 days after the index date. This postindex date GE EMR activity was required to ensure that at least a minimal amount of follow-up care or monitoring occurred after the first GE EMR documentation of diabetes and that the interaction represented the opportunity for youth to establish a usual source of care as opposed to a 1-time visit. It could be argued that this inclusion criterion was unnecessary for the present analyses. However, this step helps to ensure that insurance type is isolated from other barriers to access. Furthermore, we are evaluating

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access to diabetes-related care after diagnosis in this cohort, and a minimal amount of continuity of care was deemed necessary for the additional analyses.

By this design, all youth had at least 2 interactions with the GE EMR physician. These interactions included office visits but may have been telephone consultations, prescription orders or refills, or other activities performed by the physician or practice that led to clinical entry in the GE EMR. No minimum number of office visits was required for study inclusion. Similarly, no minimum preindex date activity period was required because the study outcome was the occurrence of physician activity during the year before the index date. Requiring GE EMR activity before the first diagnosis of type 2 diabetes could have decreased the study's sensitivity in identifying youth who had received no care in the year before the index date.

Finally, the study population included patients with Medicaid or private insurance, thereby excluding patients whose insurance type was listed as unknown, private pay, or Medicare. There were too few patients listed as having no insurance (self-pay) or Medicare in the GE EMR to support statistical analyses; therefore, these youth were not included. Conversely, there were too many patients with unknown insurance to make valid inferences about the associations between unknown insurance status and office visits.

Patients were excluded if they had a diagnosis of type 1 diabetes in the GE EMR at any time. This step helped to ensure that youth identified by fasting blood glucose levels did not have type 1 diabetes or that youth with type 1 diabetes initially diagnosed as having type 2 diabetes were not included. In addition, female patients without an ICD-9-CM diagnosis code for type 2 diabetes but with a prescription order for an oral antidiabetic agent and with a diagnosis of polycystic ovaries (code 256.4) were excluded. Oral antidiabetic agents are used off-label to treat this condition²¹⁻²³ and could have led to the inclusion of young female patients who did not have type 2 diabetes. This study did not identify or exclude young female patients with gestational diabetes; however, few female patients in this study had an indication of being pregnant on or before the index date.

Statistical Analysis

In this study, the dependent variable was the documentation of an office visit during the year before the index date, captured as a dichotomous variable. The number of office visits in the year before the index date was also identified for those with an office visit, captured as a continuous variable, with the value set to zero if no office visits were identified that year. There is no evidence that annual office visits alter the likelihood of at-risk youth developing or being diagnosed as having type 2 diabetes relative to those with less frequent or more frequent office visits. However, studies²⁴⁻²⁶ of healthcare access among youth have

evaluated whether patients had seen a physician in the previous year. To be consistent and to allow for indirect comparisons between studies, the occurrence of office visits during the 1-year period before diagnoses in the GE EMR was evaluated.

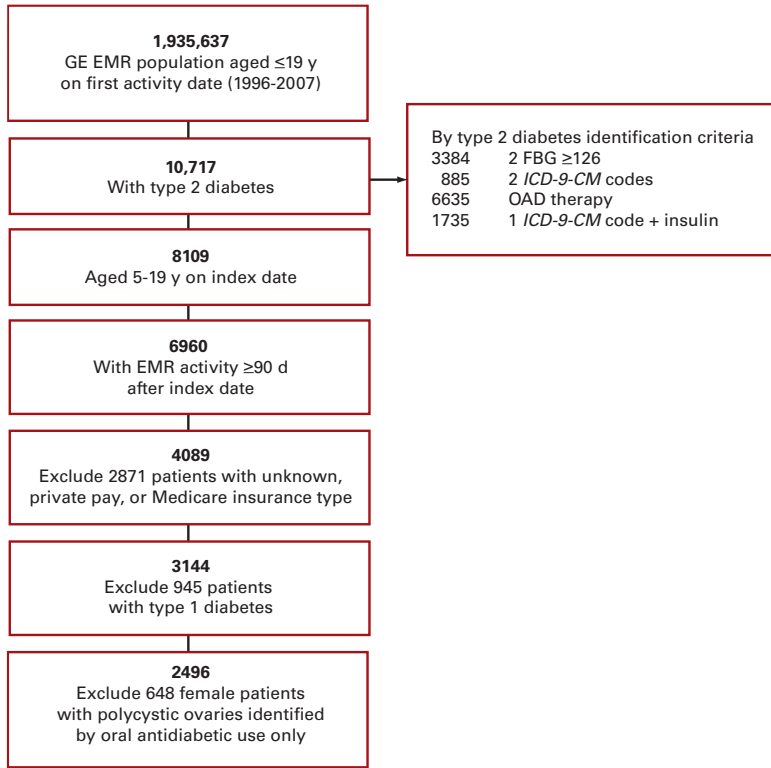
The primary independent variable was insurance type, which was categorized as Medicaid or private insurance. Insurance type in the GE EMR is recorded as of the last update; insurance type is not documented for each date when healthcare services were delivered. Therefore, the insurance type or status on record may not be the same as the insurance type on the date when type 2 diabetes was diagnosed. Details beyond Medicaid or commercial coverage are not included in the GE EMR database. Therefore, the GE EMR does not indicate whether commercial patients have employer-sponsored or individual coverage. Similarly, the database does not distinguish between Medicaid fee-for-service or managed Medicaid. It was assumed for this study that all youth with Medicaid, regardless of funding mechanism, were coded as having Medicaid and that those with managed Medicaid were not listed as having commercial insurance.

Additional independent variables were captured to describe the cohort and to control for baseline characteristics that could influence the occurrence of an office visit, including age on the index date, sex, race/ethnicity, region of residence, baseline (between 90 days before the index date and 30 days after the index date) glycosylated hemoglobin (A1C) level, and baseline body mass index (BMI). The BMI used was the value reported on the index date or up to 1 year after the index date and was used to identify youth who were overweight or obese based on their being in at least the 85th and 95th BMI percentiles for age and sex, respectively.^{27,28} Because percentiles were not available in the database, a published algorithm to convert BMI to sex-specific and age-specific percentiles was used.^{29,30} Common conditions on or before the index date, including asthma, acne, otitis media, pharyngitis, and pregnancy, were identified because these could have influenced the number of office visits before the index date. Finally, the duration of GE EMR activity before the index date was captured.

The number and proportions of youth with an office visit during the year before the index date were reported overall and by insurance type, as was the mean number of office visits in that year. In addition, the number and percentage of youth by specific office visit number were reported overall and by insurance type.

Descriptive statistics were used to describe the study cohort overall and by insurance type, as well as to identify differences in the occurrence and number of office visits during the year before the index date. Data for A1C level and BMI were not reported for some youth because the tests or measurements were not performed or because the data were not recorded in specific data fields for analysis. Therefore, the mean values for

■ **Figure 1.** Study Cohort Comprising Youth With Type 2 Diabetes in the General Electric Electronic Medical Record (GE EMR) Database From 1996 Through 2007



FBG indicates fasting blood glucose level (in milligrams per deciliter [to convert to millimoles per liter, multiply by 0.0555]); ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*; OAD, oral antidiabetic drug.

A1C level and BMI were reported for the youth with data. Between-group differences were evaluated using independent-sample *t* test or Wilcoxon rank sum test for continuous variables depending on whether the data were normally distributed. Pearson product moment correlation χ^2 test was used for categorical variables.

Univariate analyses were used to identify associations between insurance type and youth characteristics and the likelihood of having an office visit during the year before the index date, and a multivariate logistic regression analysis was used to identify the likelihood of Medicaid-covered youth having an office visit in the year before the index date relative to those with private insurance, controlling for baseline characteristics. A zero-inflated negative binomial regression analysis was then used to identify associations between insurance type and the number of office visits before the index date, controlling for baseline characteristics. Zero-inflated negative binomial regression is a 2-component model designed to evaluate a count outcome in which there is an overdispersion of zeros in the outcome variable.³¹ In application to this study, one component of the zero-inflated negative binomial model accounted for the notion that some youth in the popu-

lation will always have a zero value for office visits, while others may have zero or a positive number of office visits. The second component then estimated the number of office visits by insurance type, controlling for youth characteristics of race/ethnicity, region of residence, baseline BMI, and baseline diagnoses of asthma, acute respiratory infection, or acute pharyngitis.

It was noted during the regression modeling processes that A1C level, which was missing for almost 80% of the cohort, introduced a selection bias because there was a significant association between A1C reporting and insurance type ($P < .001$). The A1C level was omitted from the regression model; therefore, youth without A1C data were included in the analysis. The BMI was missing for approximately 41% of youth. Body mass index reporting did not differ by insurance type, and a selection bias was not identified; thus BMI was retained. As a result, only youth with BMI data were included in the regression analyses.

RESULTS

The study population was extracted from a cohort of 8109 youth aged 5 to 19 years in the GE EMR database from January 1996 through December 2007 with documentation of type 2 diabetes (Figure 1). The final study population included 2496 youth who met all study inclusion criteria, including 400 (16.0%) with Medicaid coverage and 2096 (84.0%) with private insurance.

Baseline Characteristics

The baseline characteristics of the study population are given in Table 1. The mean age of the cohort was 14.5 years, and 61.9% were female. Among those with BMI data, 68.8% were obese. Some characteristics varied between youth with Medicaid coverage and those with private insurance, including race/ethnicity, region of residence, and baseline BMI. Approximately 85% of study participants had clinical activity recorded in the GE EMR before their index date. The mean number of days of preindex date GE EMR activity for youth with private insurance (587 days) was 23 days greater than that for youth with Medicaid (564 days), but this difference was not statistically significant. Except for pregnancy, which was more frequent among the Medicaid-covered youth ($P < .007$), there was no difference in the documentation of common health condi-

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Table 1. Baseline Characteristics of Youth With Type 2 Diabetes in the General Electric Electronic Medical Record (GE EMR) Database by Medicaid or Private Insurance

Characteristic	Overall (N = 2496)	Private Insurance (n = 2096)	Medicaid (n = 400)	P ^a
Age, mean (SD), y	14.5 (3.8)	14.4 (3.8)	14.7 (3.4)	.16
Sex, No. (%)				.34
Female	1544 (61.9)	1288 (61.5)	256 (64.0)	
Male	952 (38.1)	808 (38.5)	144 (36.0)	
Race/ethnicity, No. (%)				<.001
White	870 (34.9)	761 (36.3)	109 (27.3)	
Black	270 (10.8)	193 (9.2)	77 (19.3)	
Other	198 (7.9)	150 (7.2)	48 (12.0)	
Unknown	1158 (46.4)	992 (47.3)	166 (41.5)	
Region of residence, No. (%)				<.001
Northeast	1073 (43.0)	947 (45.2)	126 (31.5)	
South	751 (30.1)	566 (27.0)	185 (46.3)	
Midwest or West	672 (26.9)	583 (27.8)	89 (22.3)	
Baseline body mass index	(n = 1483)	(n = 1233)	(n = 250)	.01
Mean (SD) ^b	33.2 (10.2)	32.8 (10.0)	34.9 (11.2)	
Normal or underweight, No. (%)	260 (17.5)	226 (18.3)	34 (13.6)	.20
Overweight, No. (%)	202 (13.6)	167 (13.5)	35 (14.0)	—
Obese, No. (%)	1021 (68.8)	840 (68.1)	181 (72.4)	—
Baseline glycosylated hemoglobin level	(n = 536)	(n = 419)	(n = 117)	
Mean (SD), %	7.8 (2.8)	7.8 (2.9)	7.7 (2.6)	.97
%				.33
<7.0, No. (%)	278 (51.9)	222 (53.0)	56 (47.9)	
≥7.0, No. (%)	258 (48.1)	197 (47.0)	61 (52.1)	
No. of days of preindex date GE EMR activity				
Mean (SD)	582 (748)	587 (752)	564 (730)	.51
First activity, No. (%)				.24
Was index date	388 (15.5)	316 (15.1)	72 (18.0)	
Was 1-364 days preindex date, No. (%)	1040 (41.7)	885 (42.2)	155 (38.8)	
Was ≥365 days preindex date	1068 (42.8)	895 (42.7)	173 (43.3)	
Condition on or before index date, No. (%)				
Asthma	121 (4.8)	100 (4.8)	21 (5.3)	.68
Acne	40 (1.6)	34 (1.6)	6 (1.5)	.86
Acute respiratory infection	188 (7.5)	154 (7.3)	34 (8.5)	.42
Otitis media	80 (3.2)	67 (3.2)	13 (3.3)	.96
Acute pharyngitis	103 (4.1)	86 (4.1)	17 (4.3)	.89
Pregnancy	46 (1.8)	32 (1.5)	14 (3.5)	.007

^aDifference between insurance type by Wilcoxon rank sum test for continuous variables (glycosylated hemoglobin level, body mass index, and days of GE EMR activity before the index date), as data were not normally distributed; χ^2 test was used for categorical variables. Boldface in the 3 right columns indicates statistical significance.

^bCalculated as weight in kilograms divided by height in meters squared.

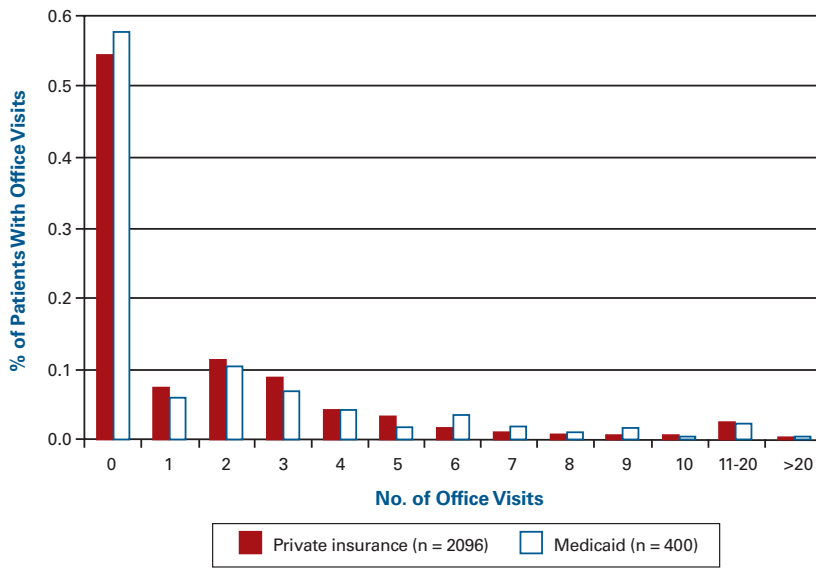
tions of childhood on or before the index date between those with Medicaid and those with private insurance.

Office Visits

Fifty-five youth did not have a recorded office visit with a

GE EMR physician during the 1-year period before the index date in the database. The mean number of office visits in that year was 1.9 and did not differ by insurance type. There was also no difference in the proportion of youth with an office visit or in the specific number of office visits between youth

■ **Figure 2.** Regression Analysis Results for Out-of-Pocket Medical Expenditures, Employment, and Workdays Missed Among Respondents With Cancer Relative to Respondents Without Cancer^a



^a*P* > .05, Medicaid versus private insurance for distribution of youth by the number of office visits.

with Medicaid versus private insurance (Figure 2). On univariate analysis, youth of unknown race/ethnicity, those residing in the South and the Midwest or West regions, obese youth, and those with any of the measured health conditions were significantly more likely to have an office visit than white youth, those residing in the Northeast, normal or underweight youth, and those without the measured health conditions (Table 2). Male patients and youth with a baseline A1C level of at least 7.0% were less likely to have had an office visit than female patients or youth with a baseline A1C level of less than 7.0%.

Logistic regression analysis was used to estimate the likelihood of Medicaid-covered youth having an office visit during the year before the index date in the GE EMR relative to youth with private insurance (Table 2), controlling for baseline characteristics that could independently influence the occurrence of an office visit. The final logistic regression model was parsimonious; therefore, it controlled only for those independent variables that were significantly associated with office visits or that contributed to the predictive ability of the model, including race/ethnicity, region of residence, baseline BMI, and diagnoses of asthma, acute respiratory infection, and acute pharyngitis before the index date. The final logistic regression model indicated no significant difference in the likelihood of having an office visit during the year before the index date between youth with Medicaid versus private insurance (odds ratio, 0.77; *P* = .09).

A zero-inflated negative binomial regression analysis was performed to identify if having Medicaid versus private insur-

ance influenced the number of office visits with a GE EMR physician during the year before the index date. Controlling for race/ethnicity, region of residence, baseline BMI, and diagnoses of asthma, acute respiratory infection, otitis media, and acute pharyngitis at any time before the index date, the expected total number of office visits during the year before the index date did not differ between youth with Medicaid versus private insurance (incident rate ratio, 1.13; *P* = .16) (Table 3).

DISCUSSION

This study addressed the question of whether differences in physician access exist for youth with Medicaid coverage who develop type 2 diabetes relative to those with private insurance. Specifically, the occurrence of a physician office visit during the year before the index date was

identified for youth aged 5 to 19 years, all of whom had access to a GE EMR physician. In this cohort, the likelihood of having an office visit or having fewer office visits 1 year before the index date did not differ significantly between youth with Medicaid and those with private insurance. Although these findings do not address the issue of how physician access influences diabetes-related treatment and outcomes, they suggest that Medicaid-covered youth, when basic barriers to physician care were overcome, were not less likely than those with private insurance to have had an office visit in the year before a predetermined event.

Almost 85% of youth in this study had clinical activity in the GE EMR before their index date. In addition, the mean duration of the patient-physician relationship before the index date exceeded 1½ years. Most youth were not newly treated by the GE EMR physician; all youth had multiple interactions with their physician, and many of these likely had a usual source of care in the GE EMR physician. Therefore, the findings of this study do not suggest that access disparities are nonexistent but rather that, when other barriers to care are overcome (such as transportation and ability to find a physician with compatible office hours), physician access does not significantly differ between youth with Medicaid versus private insurance.

One reason Medicaid-covered youth in this study likely had better access to physician care than Medicaid-covered youth overall is that they may have been in a Medicaid managed care plan, as more than 65% of Medicaid recipients have

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Table 2. Logistic Regression Analysis for the Odds of Having an Office Visit the Year Before the First Documentation of Type 2 Diabetes in the General Electric Electronic Medical Record^a

Variable	No.	Unadjusted Odds Ratio (n = 2496)	P	Adjusted Odds Ratio (n = 1843)	P
Insurance type					
Private	2096	1 [Reference]	—	1 [Reference]	—
Medicaid	400	0.88	.25	0.77	.09
Age, y					
5-9	294	1 [Reference]	—	—	—
10-19	2202	1.15	.27	—	—
Sex					
Female	1544	1 [Reference]	—	—	—
Male	952	0.53	<.001	—	—
Race/ethnicity					
White	870	1 [Reference]	—	1 [Reference]	—
Black	270	0.97	.81	0.91	.66
Other	198	0.83	.26	0.90	.67
Unknown	1158	2.60	<.001	1.46	.008
Region of residence					
Northeast	1073	1 [Reference]	—	1 [Reference]	—
South	751	3.02	<.001	0.70	.02
Midwest or West	672	2.41	<.001	0.59	.002
Baseline body mass index (n = 1483)					
Normal or underweight	260	1 [Reference]	—	1 [Reference]	—
Overweight	202	1.30	.17	1.47	.06
Obese	1021	1.43	.01	1.52	.006
Baseline glycosylated hemoglobin level ≥7.0% versus <7.0%					
Condition on or before index date versus no diagnosis					
Asthma	121	3.63	<.001	1.43	.18
Acne	40	7.15	<.001	—	—
Acute respiratory infection	188	23.29	<.001	26.95	<.001
Otitis media	80	8.15	<.001	—	—
Acute pharyngitis	103	21.65	<.001	16.23	<.001
Pregnancy	46	13.36	<.001	—	—
Vaccination visit	35	13.46	<.001	—	—

^aBoldface indicates statistical significance. Age and sex were not associated with preindex date office visits in the saturated model and were not included in the final multivariate model. Baseline body mass index was also not significantly associated with preindex date office visits, but it contributed to the model fit and was included in the final model. Glycosylated hemoglobin level was predictive but introduced a selection bias and was dropped. Preindex date diagnoses of acne, otitis media, and pregnancy were not included because of few events. For multivariate analysis, pseudo $R^2 = 0.096$, $P < .001$; Hosmer-Lemeshow goodness of fit was 0.33, indicating that fit was not lacking.

at least some component of care covered under a managed Medicaid arrangement.³² By ensuring that networks serving Medicaid-covered youth provide adequate physician coverage, managed Medicaid plans could help their patients having or at risk for developing chronic conditions (such as type 2 diabetes) to overcome access barriers, thereby opening the door for screening and other preventive services.

Type 2 diabetes awareness programs could also be beneficial to this youth population. Managed care plans are well

suited to implement educational interventions to communicate the importance of maintaining a healthy body weight and to raise awareness for diabetes screening in at-risk youth. These interventions may be particularly beneficial if targeted to Medicaid-covered youth and to adults with type 2 diabetes who have children who may be at risk for developing this disease.

This study presents new data related to how insurance type influences access to physician care for youth with type

■ **Table 3.** Zero-Inflated Negative Binomial Regression Analysis for the Association Between Insurance Type and the Number of Office Visits Before the Index Date^a

Variable	No.	Unadjusted Incident Rate Ratio (n = 2496)	P	Adjusted Incident Rate Ratio (n = 1483)	P
Insurance type					
Private	2096	1 [Reference]	—	1 [Reference]	—
Medicaid	400	1.02	.80	1.13 ^b	.16
Age, y					
5-9	294	1 [Reference]	—	—	—
10-19	2202	0.64^b	<.001	—	—
Sex					
Female	1544	1 [Reference]	—	—	—
Male	952	0.84^b	.02	—	—
Race/ethnicity					
White	870	1 [Reference]	—	1 [Reference]	—
Black	270	0.64	.002	0.75	.02
Other	198	0.56	.001	0.67	.01
Unknown	1158	0.77^b	.001	0.87	.07
Region of residence					
Northeast	1073	1 [Reference]	—	—	—
South	751	0.83^b	.020	0.84	.03
Midwest or West	672	0.9 ^b	.24	1.09 ^b	.35
Baseline body mass index (n = 1483)					
Normal or underweight	260	1 [Reference]	—	1 [Reference]	—
Overweight	202	0.83	.17	0.89 ^b	.31
Obese	1021	0.97 ^a	.80	0.98 ^b	.86
Baseline glycosylated hemoglobin level ≥7.0% versus <7.0%					
	536	0.82 ^b	.100	—	—
Condition on or before index date versus no diagnosis					
Asthma	121	1.8^b	<.001	1.38	.004
Acne	40	1.29	.16	—	—
Acute respiratory infection	188	2.05	<.001	1.59	<.001
Otitis media	80	2.34^b	<.001	—	—
Acute pharyngitis	103	2.40	<.001	1.76	<.001
Pregnancy	46	2.93	<.001	—	—
Vaccination visit	35	1.28	0.2	—	—

^aBoldface indicates statistical significance. Age and sex were not associated with preindex date office visits in the saturated model and were not included in the final multivariate model. Baseline body mass index was also not significantly associated with preindex date office visits, but it contributed to the model fit and was included in the final model. Glycosylated hemoglobin level was predictive but introduced a selection bias and was dropped. Preindex date diagnoses of acne, otitis media, and pregnancy were not included because of few events. For multivariate analysis, pseudo $R^2 = 0.096$, $P < .001$; Hosmer-Lemeshow goodness of fit was 0.33, indicating that fit was not lacking. For the final multivariate model, pseudo $R^2 = 0.003$, $P < .001$. The fit for the negative binomial model was significantly better than that for the Poisson regression model (Vuong $P < .05$).

^bVariables associated with the likelihood of always having zero office visits ($P < .05$).

2 diabetes, but several study limitations warrant mention. Although youth may have clinical data and treatments that indicate the presence of a given condition, specific diagnosis codes may not be included in the medical record. Therefore, this study used multiple criteria for identifying youth with type 2 diabetes, an approach consistent with other EMR-

based studies.^{33,34} In comparing the baseline characteristics of 2496 youth with type 2 diabetes included in this study with those of youth with type 2 diabetes described in the literature in terms of age, BMI, and sex mix,^{1,8,15,18,35,36} the populations are similar, helping to validate the patient inclusion criteria used in this study.

Physician Utilization by Insurance Type Among Youth With Type 2 Diabetes

Furthermore, data related to care delivered by other providers or practices would have been included in this study only if reported to the GE EMR physician and documented in the database. Because Medicaid-covered youth are more likely to use emergency department care than those with private insurance³⁷ and because youth with private insurance have better access to specialty care,³⁸⁻⁴³ physician access during the year before the index date in the GE EMR is likely underreported.

In addition, clinical data (including A1C level and BMI) were not reported for all youth. Nonrandom missing data can introduce a selection bias or can reduce the power of the study to detect statistical differences. Because of the high rates of youth without A1C or BMI data, efforts were not made to impute missing values. Rather, means were reported for those with A1C or BMI data and may not be representative of the overall study population. Although BMI was missing in many youth, the exclusion of youth without BMI data in the regression analyses likely did not introduce a significant selection bias. Relative to those with a BMI value recorded in the GE EMR, youth without a BMI value were younger, male, and more likely to be white and had a higher baseline A1C level ($P > .01$ for all). It is difficult to predict how actual BMI values would vary between youth with and without BMI data. However, the mean BMI (33 [calculated as weight in kilograms divided by height in meters squared]) and the mean proportion of youth who were obese (68.8%) were consistent or slightly lower than what has been reported in clinic-based observational studies.^{1,18,36} Conversely, A1C level was omitted from the regression analysis because A1C reporting differed by insurance type, and the exclusion of youth without A1C data seemed to introduce a selection bias.

Race/ethnicity data, which were also frequently missing, represent a ubiquitous challenge for research based on administrative data.⁴⁴ To adjust for race/ethnicity and to avoid excluding a large proportion of the cohort, youth who did not have race/ethnicity data were grouped into an “unknown” race/ethnicity category. However, the unknown group represented almost half of the study population. As such, caution should be taken when drawing conclusions about the role of a specific racial/ethnic group on study outcomes.

Another limitation of the GE EMR is that insurance is reported as of the patient’s last update and may not reflect his or her insurance coverage at the time of diagnosis. For uninsured youth at diagnosis, many may have later been enrolled in Medicaid or a private plan to cover diabetes treatment costs. For example, low-income youth with chronic conditions are twice as likely to enroll in a public plan than their healthy peers.⁴⁵ Furthermore, changing insurance status and type may be an issue among children with Medicaid coverage, whose eligibility is assessed monthly.

In addition, the proportion of youth in this study with Medicaid coverage was 16.0%, while more than 25% of youth in the United States overall have Medicaid insurance.¹¹ The underrepresentation of Medicaid-covered youth in this study may be due to the fact that physicians who use EMRs tend to see fewer low-income and Medicaid-covered youth than physicians who do not use EMRs.⁴⁶ Furthermore, Medicaid-covered youth in this study were able to establish a patient-physician relationship. Therefore, this study may represent a select group of Medicaid-covered youth who are similar to those with private insurance in terms of being able to overcome basic access barriers.

A final limitation is the lack of socioeconomic status among the cohort. Medicaid-covered youth can be assumed to be of lower socioeconomic status, but the socioeconomic status of privately insured youth could vary. The inclusion of youth who received some care from a GE EMR physician may have controlled for socioeconomic-related factors that influence healthcare access, such as transportation. By including Medicaid-covered youth who were similar to privately insured youth in their ability to overcome these access barriers, this study may have isolated the role of insurance type from other socioeconomic factors on access to physician care.

CONCLUSIONS

Although others have identified healthcare access disparities between youth with Medicaid versus private insurance,¹² this study of youth with type 2 diabetes did not identify significant differences in the utilization of physician services during the year before the index date. However, youth in this study had multiple interactions with the GE EMR physician, and it can be assumed that all had established the GE EMR physician as a source of care. Therefore, these data represent a subset of Medicaid-covered youth who were able to overcome basic access barriers. These study findings suggest that concerns about physician utilization disparity for Medicaid-covered youth center not on which patients have a source of care but on whether they can establish access to physician care in the first place. Ongoing research is evaluating whether diabetes-related care after diagnosis in the GE EMR is influenced by insurance type and by access to physician care before the diagnosis of diabetes. Future research is also warranted to identify the determinants of a usual source of physician care for youth with chronic conditions such as type 2 diabetes.

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Author Affiliations: From the Department of Pharmacotherapy (CMM, DIB), Drexel University (RIF), Philadelphia, PA; University of Utah, Salt Lake City, UT; and the University of the Sciences in Philadelphia (RIF, SM, STM), Philadelphia, PA.

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Address correspondence to: Carrie McAdam-Marx, PhD, Department of Pharmacotherapy, University of Utah, 421 Wakara Way, Rm 208, Salt Lake City, UT 84108. E-mail: carrie.mcadam-marx@pharm.utah.edu.

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