Research Article

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Racial disparities in healthcare utilization and costs in pharmacologically treated medicaid enrollees with developmental disabilities and Type 2 diabetes

Abstract

Objective: Adults with developmental disabilities have higher prevalence of chronic disease conditions such as diabetes, obesity, high blood pressure, arthritis, CVD and chronic pain. They also have poor healthcare utilization and are screened less for chronic disease conditions. Very few studies have looked at the diabetes related health outcomes in developmentally disabled adults, where distinct racial differences in medication use behaviors have been observed. The objective of this study was to examine the association of race with healthcare utilization and costs in pharmacologically treated Medicaid enrollees with developmental disabilities (DD) and type 2 diabetes.

Methods: This was a retrospective cohort study that identified adults with DD and type 2 diabetes from the MarketScan® Multi-State Medicaid Database. Enrollees aged 18-64 years who received new medications for type 2 diabetes from January 1, 2004 and December 31, 2006 were included. An index diagnosis date was assigned to each patient and adults with a continuous enrollment for at least 12 months were included. Probabilities of type 2 diabetes related healthcare utilization (inpatient, outpatient and emergency department visits) in adults with DD were computed using multivariate logistic regression models. Multivariate negative binomial regression was used to measure the rate of change in type 2 diabetes related healthcare utilization in patients with DD. Multivariate linear regression with log-transformation was used to determine type 2 diabetes related healthcare costs in Medicaid enrollees with DD.

Results: This study had a sample size of 1529 patients. After controlling for all the covariates, compared to Caucasians with DD, African Americans with DD were more likely to have type 2 diabetes related inpatient (OR=1.71; 95% CI, 1.02-2.85) and emergency department visits (OR, 1.67; 95% CI, 1.02-2.73). African Americans with DD and type 2 diabetes had significantly higher healthcare costs compared to Caucasians with DD and type 2 diabetes.

Conclusion: Racial disparities exist in healthcare utilization in Medicaid patients with DD and type 2 diabetes. African Americans were more likely to have inpatient and ER visits respectively. Also, African Americans were more likely to have higher type 2 related healthcare costs compared to Caucasians.

Keywords: racial disparities, type 2 diabetes, developmental disabilities, autism, cerebral palsy, down syndrome, healthcare utilization

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Introduction

Diabetes Mellitus, a serious metabolic disorder is the seventh leading cause of death in the United States (US).[1-5] The cost of diabetes related healthcare places a huge burden on the US economy with treatment costs and loss of productivity estimated to rise to $336 billion in 2034.[1-5] Individuals with disabilities make up just 15% of all the Medicaid enrollees and yet are accountable for 42% of the total Medicaid expenses (Kaiser Family Foundation website). Research has shown that people with disabilities have higher rates of diabetes, depending on the type of disability.[6,7] About 15% of children in the age group of 3-17 years have disabilities like ADHD, cerebral palsy, (CP) hearing loss, intellectual disability, Down syndrome, learning disability, vision impairment, autism spectrum disorders (ASDs) and other developmental delays.[8] Sedentary lifestyle, poor nutrition and high rates of obesity lead to increased risk of type 2 diabetes in patients with DD.[9,10] In addition, people with DD might feel socially excluded, have limited access to medical care and leisure facilities, and tend to have high blood pressure.[11] When patients with DD live independently, there is a higher likelihood of an unhealthy lifestyle with less dietary restrictions.[12] In 2006, the prevalence of diabetes in adults with cognitive disabilities was 19.4% compared to 3.8% in patients without cognitive disabilities.[13]

A study conducted using the 2001 North Carolina Behavioral Risk Factor Surveillance System and the North Carolina National Core Indicators survey showed that compared to disabled adults without DD, adults with DD were less physically active, received seven times less emotional support, had high health risk behaviors, and had low breast cancer and cervical cancer screenings.[14,15] The comorbid conditions associated with DD are more likely to be found among adults with low income, who also face socioeconomic disparities in access to healthcare.[16] In North America, the prevalence of type 2 diabetes in the population with DD can vary from 7.1% to 14%.[7,14,17,18] Diabetic patients without a usual source of care have also reported significantly higher HbA1c levels than patients receiving care at doctor's clinics.[19] Medication adherence to antidiabetic medications has been associated with fewer hospitalizations[20] and lower health-care costs[21] in patients with diabetes. Some of the common causes of non-adherence among adults with DD are fragmentation of care, comorbidity, polypharmacy, and consideration of medication side effects.[22] Paying for healthcare and prescriptions may compete with other basic needs and priorities and may create strong bottlenecks for access and adherence. A study by Heisler et al.[23] found that racial minorities were twice as likely to cut down on necessities and incur debt in order to cope with medication costs compared to white respondents.

Due to cognitive and physical impairment, people with DD can find diabetes self-management (medication adherence, proper diet and exercise and monitoring HbA1c levels) challenging and exhausting.[24] Also, people with DD tend to rely on their caregivers for their type 2 diabetes care management. Caregivers of people with DD can feel inadequate in managing their type 2 diabetes due to lack of necessary educational materials and equipment.[11] Optimum type 2 diabetes management is difficult to achieve in people with DD due to continuously elevated blood glucose levels arising from lower medication adherence, thereby leading to an increased risk of type 2 diabetes related complications, and further impacting healthcare utilization and quality of life of people with DD.[17,24] The literature looking at healthcare utilization and costs in patients with DD and type 2 diabetes is scarce and furthermore, our previous research has shown that there exist distinct racial disparities in diabetes medication use[25,26] both in the Medicaid population and in patients with DD. Such disparity could have an impact on health care service utilization and costs in developmentally disabled adults in the Medicaid program. Lower type 2 diabetes medication adherence has shown to be associated with higher rates of avoidable health care use such as hospitalizations or emergency department visits;[27] however no study has previously examined these issues in the population of patients with developmental disabilities with concurrent type 2 diabetes. African Americans tend to have fewer type 2 diabetes related primary care visits and laboratory testing, which in turn increases their risk of emergency department visits.[28] The present study aims to fill this gap by examining racial disparities in healthcare utilization, primarily inpatient visits, outpatient visits, ER visits and healthcare costs in patients with DD and type 2 diabetes enrolled in Medicaid receiving pharmacological treatment.

Methods

Data sources

The Marketscan Multi-State Medicaid database was used for conducting this study. It is a pooled Medicaid dataset that consists of claims from eight states in the United States and has variables that provide information about disease conditions, clinical outcomes and demography of the enrolled subjects. The dataset also has information about the enrollment periods of the enrollees, claims for inpatient visits, outpatient visits and prescriptions. The diagnoses in the dataset were identified using the ICD-9-CM codes. Each patient is assigned a confidential enrollee identifier and this identifier can be used to track patients longitudinally. The identifier is also same across different sets of claims.[29]

Sample selection

This retrospective cohort study was conducted with data from January 1, 2003 to December 31, 2007. Patients aged 18-64 years with diagnosis of DD and a new prescription of oral hypoglycemic medications during January 1, 2004 and December 31, 2006 were included in the study. Each patient was assigned an index diagnosis date. Only drug naïve patients, i.e. patients who did not have any drug claims during the 12 months before the index diagnosis date, were included in the study. If patients were drug naïve, it was an indication that the patients were new users. Patients with continuous Medicaid enrollment for 12 months before and after the index diagnosis date were included in the study. Patients with claims for insulin and patients who were dual eligibles were excluded. After applying inclusion and exclusion criteria, the total sample size was 1,529. Table 5.1 represents the ICD-9-CM codes for DD.

Study variables

Dependent variables: The main dependent variables were type 2 diabetes related healthcare utilization and type 2 diabetes healthcare costs. Type 2 diabetes related healthcare utilization variables included inpatient visits, outpatient visits and ER visits respectively. Type 2 diabetes related healthcare costs included medication costs, medical costs (inpatient costs + outpatient costs) and overall costs (medication costs + medical costs) respectively. The term "patients with type 2 diabetes and DD" included patients with a primary diagnosis of DD (autism, cerebral palsy, Down syndrome, cognitive disability) and a secondary diagnosis of type 2 diabetes. The ICD-9-CM codes for DD were 299.0x (autism, where x=0-2), 317, 318.x and 319 (intellectual disabilities, where x=0-2), 343.x (cerebral palsy, where x=0-9) and 758 (Down syndrome) and for type 2 diabetes were 250.x (where x=0,2). All the patient healthcare utilization variables (inpatient visits, outpatient visits and ER visits) with the above ICD-9-CM codes were defined as type 2 diabetes related healthcare utilization in patients with DD. Each healthcare utilization variable was coded dichotomously (yes/no). For example, type 2 diabetes related outpatient visits were coded 'yes' for patients having at least one outpatient visit (yes) and 'no' for patients having no outpatient visits during the study period. The healthcare costs variable was defined as the healthcare costs incurred by the patients during the study period. Healthcare costs were categorized as medication costs, medical costs and overall costs.

Key independent variables: Race, medication adherence and the interaction of race and medication adherence were the three main independent variables in the study. The variable race was obtained from the participants upon enrollment into Medicaid. Race was categorized as Caucasians, African Americans, and other races. Medication adherence was calculated using the modified Medication Possession Ratio (MPRm). MPRm includes the patient's last day of type 2 diabetes medication supply was also one of the covariates in the study. MPRm was categorized as high adherence if the value was greater than 0.8 and low adherence if the value was less than or equal to 0.8.[30,31] Claims for type 2 diabetes medications were identified in patients with DD during the enrollment period after their index diagnosis date. The interaction term was the interaction between race and medication adherence (MPRm).

Covariates: Andersen's model of healthcare utilization

The covariates in this study were based on Andersen's model of healthcare utilization.[32,33] According to this model, predisposing factors, enabling factors and need factors can predict healthcare utilization.[32-35] For the purposes of this study, predisposing factors included age (grouped as 18-30, 31-40, 41-50, 51-60, and 61-64 years) and gender. The enabling factors determine access to healthcare. In this study, the enabling factor was the type of health plan (fee-for-service, capitation, and dual). The need factors in the study were number of prescription refills (2-5, 5-10 and >10) and severity of the disease, which was measured by the number of outpatient visits during the pre-index period (yes/no), the number of inpatient visits during the pre-index period (yes/no), the Charlson comorbidity index during the pre-index period (0 and ≥1) and the Charlson comorbidity index during the study duration.[34,35]

Charlson comorbidity index

This study used the Charlson comorbidity index, an index consisting of 17 different disease conditions used to predict mortality associated with the severity of comorbid conditions. The Charlson index assigns weights of 1, 2, 3 or 6 to the 17 comorbid conditions based on their severity. The diseases that have a higher impact on mortality such as cancer or AIDS have a weight of 6 as opposed to conditions such as myocardial infarction and congestive heart failure that are assigned a weight of 1. All the weights for the 17 comorbidities are totaled for each patient to calculate the index severity score.[36,37] The Charlson index, though mainly developed for measuring mortality as an outcome, is now being used to measure outcomes such as healthcare utilization and healthcare costs.[38] The Charlson index has been adapted for its use in administrative claims databases.[39-41] This study uses the Deyo's modification of the Charlson index as a measure to assess the overall severity of the illness in the study population.

Statistical analyses

Descriptive statistics were computed to study the patient characteristics. Healthcare utilization (outpatient visits, inpatient visits and ER visits) was compared using Student's t-test. Comparison between Caucasians and African Americans on healthcare costs (medication costs, medical costs and overall costs) was also conducted using Student's t-test. Multivariate regression analysis was performed to determine the association between type 2 diabetes related healthcare utilization (number of outpatient visits, number of inpatient visits, and number of ER visits), and race, medication adherence (MPRm) and their interaction. First, multivariate logistic regression analyses were done to estimate the probability of occurrence of any of the healthcare utilization dependent variables (outpatient visits, inpatient visits and ER visits). Then, multivariate negative binominal regression analyses were performed to determine the change in outpatient visits given the patients had at least one outpatient visit. Similarly, multivariate zero negative binominal regression analyses were conducted to determine the change in inpatient and ER visits, given the patients had at least one inpatient and ER visit respectively. Multivariate linear regression analyses were used to predict log-transformed healthcare costs as a function of race, medication adherence, their interaction, and other covariates. In the study, data management was performed using SAS v.9.3.[42] All the data analysis was completed using STATA 13[43] Statistical significance was determined by obtaining a 0.05 level of significance in two tailed tests and other analyses. This study was approved by the Institutional Review Board (IRB) at the University of Michigan.

Results

Table 2 describes the demographic characteristics of the study population. Among 1529 Medicaid enrollees with DD and type 2 diabetes, 28.97% people were aged 18-30 years, 57.49% were females, 42.12% were African Americans, 97.65% had an outpatient visit during the pre-index period and 26.10% had an inpatient visit during the pre-index period.

Table 3 illustrates the mean differences in healthcare utilization (number of outpatient visits, number of inpatient visits and number of ER visits) among different races with DD and type 2 diabetes. Compared to Caucasians with DD and type 2 diabetes, African Americans with DD and type 2 diabetes had significantly less number of outpatient visits (125.67 versus 107.93, p<0,05). Also, among patients with DD and type 2 diabetes, compared to Caucasians, African Americans had higher number of inpatient visits (0.77 versus 1.02) and ER visits (2.66 versus 3.17) respectively, even though these differences were not statistically significant.

Table 4 presents the mean differences in healthcare costs (medication costs, medical costs and overall costs) among different races with DD and type 2 diabetes. Compared to Caucasians with DD and type 2 diabetes, African Americans with DD and type 2 diabetes had significantly higher medication costs ($1284.69 versus $1114.85, p<0,05). Similarly, among patients with DD and type 2 diabetes, compared to Caucasians, African Americans had higher medical costs ($39248.37 versus $43423.2) and overall costs ($40363.22 versus $44707.89) respectively, even though these differences were not statistically significant.

Table 1 ICD-9-CM codes*

Disease	Diagnosis	Codes±
Cerebral Palsy	Infantile cerebral palsy	343
	Congenital Diplegia	343.0
	Congenital Hemiplegia	343.1
	Congenital Quadriplegia	343.2
	Congenital Monoplegia	343.3
	Infantile Hemiplegia	343.4
	Other specified infantile cerebralpalsy	343.8
	Cerebral Palsy, unspecified	343.9
Autism	Infantile autism	299.0
	Autistic Discord-Current	299.00
	Autistic Discord-Residual	299.01
Down syndrome	Down syndrome	758.0
Mental retardation	Mild mental retardation	317
	Moderate mental retardation	318.0
	Severe mental retardation	318.1
	Profound mental retardation	318.2
	Unspecified mental retardation	319

*ICD-9-CM: International classification of diseases, ninth revision, clinical modification

Table 2 Descriptive characteristics of the study population (N= 1529)

	Frequency	%
Race		
Caucasians	788	51.54
African Americans	644	42.12
Other races	97	6.44
Age (Years)		
18-30	443	28.97
31-40	362	23.68
41-50	394	25.77
51-60	275	17.99
61-64	55	3.6
Gender		
Male	650	42.51

Table Continued...

	Frequency	%
Female	879	57.49
FFS vs. Capitation		
FFS	1150	75.21
Capitation	312	20.41
Dual	67	4.38
Comorbidity (Charlson Index)		
0	917	59.97
≥1	612	40.03
Comorbidity pre-index period (Charlson Index)		
0	1036	67.76
≥1	493	32.24
Inpatient visit pre-index period		
0	1130	73.9
1	399	26.1
Outpatient visit pre-index period		
0	36	2.35
1	1493	97.65
Number of Medication refills		
2-5	1187	77.63
6-10	211	13.8
>10	131	8.57

Table 3 Racial differences in healthcare utilization in type 2 diabetes patients with DD (N= 1529)

Healthcare Utilization	Caucasians		African Americans	
	Mean (N=788)	SD	Mean (N=644)	SD
No. of outpatient visits	125.67	195.39	107.93*	178.3
No. of inpatient visits	0.77	1.83	1.02	2.96
No. of ER visits	2.66	4.98	3.17	7.66

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Student's T -test of healthcare utilization between Caucasians and African Americans

Table 4 Racial differences in healthcare costs in type 2 diabetes patients with DD (N= 1529)

Healthcare Costs	Caucasians		African Americans	
	Mean (N=788)	SD	Mean (N=644)	SD
Cost of medications	1114.85	1687.92	1284.69*	1822.73
Medical costs	39248.37	2520.66	43423.2	2586.64
Overall costs	40363.22	2530.09	44707.89	2601.27

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Medical costs = Inpatient costs + Outpatient costs

Overall costs = Cost of medications + Medical costs

Student's T -test of healthcare costs between Caucasians and African Americans

Table 5 shows the association between race, medication adherence and their interaction with type 2 diabetes related healthcare utilization in Medicaid patients with DD, using multivariate logistic regression models. Controlling for all the other covariates, the adjusted odds of having type 2 diabetes related inpatient visits in African Americans with DD were 1.7 times greater than the adjusted odds of having type 2 diabetes related inpatient visits in Caucasians with DD (OR =1.71, 95% CI = 0.53-1.16, p<0.05). Controlling for all the other covariates, the adjusted odds of having type 2 diabetes related ER visits in African Americans with DD were 1.67 times greater than the adjusted odds of having type 2 diabetes related inpatient visits in Caucasians with DD (OR =1.67, 95% CI=1.03-2.73, p<0.05). The interaction between race and medication adherence was significant. After controlling for all the other covariates, African American with DD and lower medication adherence had higher probability of having type 2 diabetes related ER visits compared to African Americans with DD and higher medication adherence, Caucasians with DD and higher medication adherence, and Caucasians with DD and lower medication adherence (OR = 2.05, 95% CI =1.19-3.55, p<0.05).

Tables 6 shows the association between race, medication adherence and their interaction with type 2 diabetes related healthcare utilization in Medicaid enrollees with DD. These associations were computed using multivariate negative binomial regression models. The expected number of type 2 diabetes related inpatient visits in African Americans with DD was 72% (RR =1.72, 95% CI = 1.12-2.63, p<0.05) greater compared to the expected number of type 2 diabetes related inpatient visits in Caucasians, after controlling for other covariates. The expected number of type 2 diabetes related ER visits in African Americans with DD were significantly higher than the expected number of type 2 diabetes related inpatient visits in Caucasians, after controlling for other covariates (RR =1.76, 95% CI = 1.18-2.61, p<0.01).

Table 7 presents the associations between race, medication adherence, and the interaction between race and medication adherence with log-transformed healthcare costs (medication costs, medical costs and overall costs). Among patients with type 2 diabetes and DD, after holding all the other covariates constant, higher medication adherence (≥80%) was negatively associated with medication costs (β = -0.32, p<0.01), medical costs (β = -0.48, p<0.001) and overall healthcare costs (β = -0.52, p<0.001). After holding all the other covariates constant, among patients with DD and type 2 diabetes compared to Caucasians, African American patients had 23% higher medication costs, 26% higher medical costs and 21% higher overall costs respectively. The interaction between medication adherence and race was not statistically significant for any of the three types of costs (medication costs, medical costs or overall costs).

Table 5 Predictors of healthcare utilization in type 2 diabetes patients with DD: Multivariate logistic regression models (N=1529)

	Inpatient visits		Outpatient visits		ER visits	
	Odds Ratio	95% CI	Odds Ratio	95% CI	Odds Ratio	95% CI
Adherence						
MPRm<80%	Reference	Reference	Reference	Reference	Reference	Reference
MPRm≥80%	0.78	(0.53-1.16)	1.05	(0.57-1.94)	0.59**	(0.40-0.87)
Race						
Caucasians	Reference	Reference	Reference	Reference	Reference	Reference
African Americans	1.71*	(1.02-2.85)	0.82	(0.38-1.76)	1.67*	(1.02-2.73)

Table Continued...

	Inpatient visits		**Outpatient visits**		**ER visits**	
	Odds Ratio	**95% CI**	**Odds Ratio**	**95% CI**	**Odds Ratio**	**95% CI**
Other races	1.64	(0.82-3.31)	1.12	(0.40-3.16)	1.66	(0.88-3.11)
Interaction between race and MPRm						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.35	(0.75-2.42)	0.6	(0.25-1.46)	2.05*	(1.18-3.55)
Age (years)						
18-30	Reference	Reference	Reference	Reference	Reference	Reference
31-40	0.99	(0.69-1.42)	0.77	(0.45-1.35)	0.99	(0.74-1.35)
41-50	1.46*	(1.06-2.02)	0.69	(0.40-1.19)	1.06	(0.79-1.44)
51-60	1.37	(0.95-1.97)	0.38**	(0.21-0.68)	0.86	(0.61-1.21)
61-64	2.76***	(1.57-4.85)	1.19	(0.32-4.42)	1.47	(0.80-2.71)
Gender						
Male	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.96	(0.75-1.23)	1.32*	(0.89-1.95)	1.42**	(1.14-1.78)
FFS vs. Capitation						
FFS	Reference	Reference	Reference	Reference	Reference	Reference
Capitation	1.15	(0.83-1.58)	1.01	(0.64-1.58)	1.47**	(1.11-1.96)
	1.49	(0.87-2.54)	1.00	(omitted)	1.73	(0.99-3.03)
Dual Comorbidity (Charlson Index)						
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	1.61***	(1.38-1.86)	1.66**	(1.16-2.36)	1.62***	(1.34-1.96)
Comorbidity pre-index period (Charlson Index)						
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	1.00	(0.83-1.21)	0.85	(0.57-1.26)	1.06	(0.85-1.32)
Inpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.85***	(1.57-2.18)	0.98	(0.81-1.18)	2.06***	(1.67-2.54)
Outpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.00**	(1.00-1.00)	1.06***	(1.05-1.08)	1.00**	(1.00-1.00)
Number of Medication refills						
2-5	Reference	Reference	Reference	Reference	Reference	Reference
6-10	1.28	(0.78-2.08)	2.36**	(1.38-4.05)	1.15	(0.76-1.75)
>10	1.63*	(1.10-2.40)	12.38***	(7.32-20.92)	1.53*	(1.10-2.14)
Constant	0.09***	(0.05-0.16)	0.55	(0.25-1.19)	0.43***	(0.21-0.54)
Adjusted R2	0.16		0.29		0.13	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6 Predictors of healthcare utilization in type 2 diabetes patients with DD: Multivariate negative binomial regression models (N=1529)

	Inpatient visits		**Outpatient visits**		**ER visits**	
	Relative Risk	**95% CI**	**Relative Risk**	**95% CI**	**Relative Risk**	**95% CI**
Adherence						
MPRm<80%	Reference	Reference	Reference	Reference	Reference	Reference
MPRm≥80%	0.8	(0.60-1.07)	1.13	(0.93-1.35)	0.50***	(0.38-0.67)
Race						
Caucasians	Reference	Reference	Reference	Reference	Reference	Reference
African Americans	1.72*	(1.12-2.63)	0.95	(0.76-1.19)	1.76**	(1.18-2.61)
Other races	1.27	(0.73-2.22)	0.78	(0.59-1.03)	1.39	(0.85-2.28)
Interaction between race and MPRm						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.47	(0.90-2.39)	0.96	(0.75-1.24)	1.88**	(1.22-2.91)
Age (years)						
18-30	Reference	Reference	Reference	Reference	Reference	Reference

Table Continued...

	Inpatient visits		Outpatient visits		ER visits	
	Relative Risk	**95% CI**	**Relative Risk**	**95% CI**	**Relative Risk**	**95% CI**
31-40	1.08	(0.78-1.48)	1.17*	(1.00-1.36)	0.92	(0.72-1.17)
41-50	1.18	(0.89-1.57)	1.12	(0.96-1.30)	0.9	(0.71-1.14)
51-60	1.14	(0.82-1.57)	0.99	(0.85-1.15)	0.73*	(0.56-0.95)
61-64	1.57*	(1.03-2.45)	1.07	(0.79-1.47)	0.85	(0.52-1.38)
Gender						
Male	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.96	(0.78-1.19)	1.17**	(1.04-1.30)	1.20*	(1.00-1.43)
FFS vs. Capitation						
FFS	Reference	Reference	Reference	Reference	Reference	Reference
Capitation	1.08	(0.83-1.40)	0.79***	(0.69-0.90)	1.57***	(1.26-1.95)
	1.3	(0.88-1.93)	1.38*	(1.08-1.77)	1.78**	(1.22-2.60)
Dual Comorbidity (Charlson Index)						
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	1.51***	(1.37-1.67)	1.15***	(1.09-1.21)	1.40***	(1.28-1.53)
Comorbidity pre-index period (Charlson Index)						
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	0.97*	(0.87-1.07)	0.92**	(0.86-0.98)	1.01	(0.91-1.11)
Inpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.47***	(1.37-1.58)	1.03	(0.99-1.07)	1.33***	(1.24-1.42)
Outpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	1.00**	(1.00-1.00)	1.01***	(1.01-1.01)	1.00***	(1.00-1.00)
Number of Medication refills						
2-5	Reference	Reference	Reference	Reference	Reference	Reference
6-10	1.09	(0.74-1.60)	1.2	(1.00-1.45)	0.98	(0.70-1.38)
>10	1.92***	(1.38-2.66)	3.21***	(2.75-3.75)	1.74***	(1.31-2.31)
Constant	0.15***	(0.09-0.25)	15.16***	(12.13-18.96)	0.83	(0.55-1.25)
Alpha	1.83	(1.52-2.22)	0.67	(0.62-0.73)	1.77	(1.57-1.99)
Likelihood-ratio (LR)	Chibar2(01) = 860.88		Chibar2(01) = 3.15e+05		Chibar2(01) = 4492.06	
Test of alpha=0	Prob>=Chibar2 = 0.000		Prob>=Chibar2 = 0.000		Prob>=Chibar2 = 0.000	
Vuong test	Z = 5.53; Prob>z=0.054		Z = -14.2; Prob>z =0.054		Z = 4.70; Prob>z=0.052	
Log likelihood	-1677.45		-8044.52		-3027.41	

Note: * p < 0.05, ** p < 0.01, *** p < 0.001

Ω: Negative binomial regression model

Table 7 Predictors of healthcare costs in type 2 diabetes patients with DD: Multivariate linear regression models (N=1529)

	Medication costs		Medication costs		Overall costs	
	β coefficient	**SE**	**β coefficient**	**SE**	**β coefficient**	**SE**
Adherence						
MPRm<80%	Reference	Reference	Reference	Reference	Reference	Reference
MPRm≥80%	-0.32**	0.11	-0.48***	0.12	-0.52***	0.11
Race						
Caucasians	Reference	Reference	Reference	Reference	Reference	Reference
African Americans	0.23**	0.08	0.26**	0.09	0.21*	0.09
Other races	0.08	0.13	0.19	0.17	0.14	0.16
Interaction between race and MPRm						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	-0.27	0.16	-0.11	0.18	-0.09	0.17
Age (years)						
18-30	Reference	Reference	Reference	Reference	Reference	Reference
31-40	0.01	0.09	-0.04	0.11	-0.01	0.1
41-50	0.1	0.09	-0.04	0.11	0.04	0.1

Table Continued...

	Medication costs		Medication costs		Overall costs	
	β coefficient	**SE**	**β coefficient**	**SE**	**β coefficient**	**SE**
51-60	0.08	0.09	-0.16	0.13	-0.07	0.11
61-64	0.22	0.16	0.25	0.19	0.24	0.18
Gender						
Male	Reference	Reference	Reference	Reference	Reference	Reference
Female	-0.01	0.07	0.02	0.08	-0.03	0.07
FFS vs. Capitation						
FFS	Reference	Reference	Reference	Reference	Reference	Reference
Capitation	0.07	0.08	-0.70***	0.1	-0.69***	0.09
Dual Comorbidity (Charlson Index)	0.24	0.14	0.29	0.05	0.24	0.16
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	0.12***	0.03	0.29***	0.04	0.25***	0.04
Comorbidity pre-index period (Charlson Index)						
0	Reference	Reference	Reference	Reference	Reference	Reference
≥1	-0.10*	0.04	-0.08	0.05	-0.08	0.05
Inpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	0.02	0.02	0.13***	0.03	0.12***	0.03
Outpatient visit pre-index period						
0	Reference	Reference	Reference	Reference	Reference	Reference
1	-0.00**	0.00	0.01***	0.00	0.01***	0.00
Number of Medication refills						
2-5	Reference	Reference	Reference	Reference	Reference	Reference
6-10	1.21***	0.11	0.94***	0.13	1.04***	0.12
>10	2.77***	0.08	2.25***	0.1	2.47***	0.09
Constant	3.96***	0.13	7.17***	0.15	7.26***	0.14
Adjusted R2	0.44		0.37		0.43	

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Discussion

Our study found that African Americans with DD and type 2 diabetes had higher healthcare expenditures, ER visits and inpatient visits compared to Caucasians with DD and type 2 diabetes. This study provides the first comprehensive account about healthcare outcomes in diabetic adults with DD. Understanding the predictors of healthcare outcomes associated with different chronic disease conditions can help in the comprehensive management of the adults with DD. The study variables were based on Andersen's model of healthcare utilization. This model provided a theoretical background for the study. It allowed researchers to control for predisposing, enabling, and need factors that helped in explaining the racial disparities in medication use outcomes and healthcare utilization in Medicaid enrollees with DD and type 2 diabetes. The study also has good generalizability since the Medicaid population chosen as the study population represented eight states.

Our finding about racial disparities in type 2 diabetes related healthcare utilization is in line with previous studies which state that not only are Medicaid-enrolled African American patients at a risk for worse diabetes medication adherence[25] but also are Medicaid-enrolled African American patients with type diabetes and DD.[26] Adults with DD visit the ED department to a far larger extent than adults without DD; this can be attributed to the lack of continuous primary and specialized care, and lack of sufficient outpatient centers providing mental and physical care.[18]

Our results indicate that African American patient with DD and type 2 diabetes have a higher risk of type 2 diabetes related inpatient visits. Patients with DD require special accommodations during their physical examination in inpatient and outpatient settings. People with DD can require nearly thrice the time for a physical compared to patients without cognitive disabilities due to barriers such as difficulty in communicating symptoms, inability to tolerate longer waiting times, aggressive behavior or reluctance to get a physical. They also fear needles, examination of private areas, and new physicians and need physical assistance for many procedures.[44]

It can be quite challenging for minority patients with DD and other chronic disease conditions to access and utilize healthcare services. Hence the interaction term (being African American and having low medication adherence) shows a reduced effect on healthcare utilization. The risk of higher ED visits and inpatient visits can be reduced by providing better primary care and outpatient services. Higher number of primary and specialty providers accepting Medicaid patients, and access to culturally sensitive and competent minority healthcare providers with cultural backgrounds similar to minority patients', can improve patient outcomes. During patient encounters, physicians should use respectful language and terminologies and provide language assistance/translation services if feasible. Increasing rates of out of home placement can help in chronic disease management and rehabilitation of minority patients with DD and other chronic diseases.[45-49]

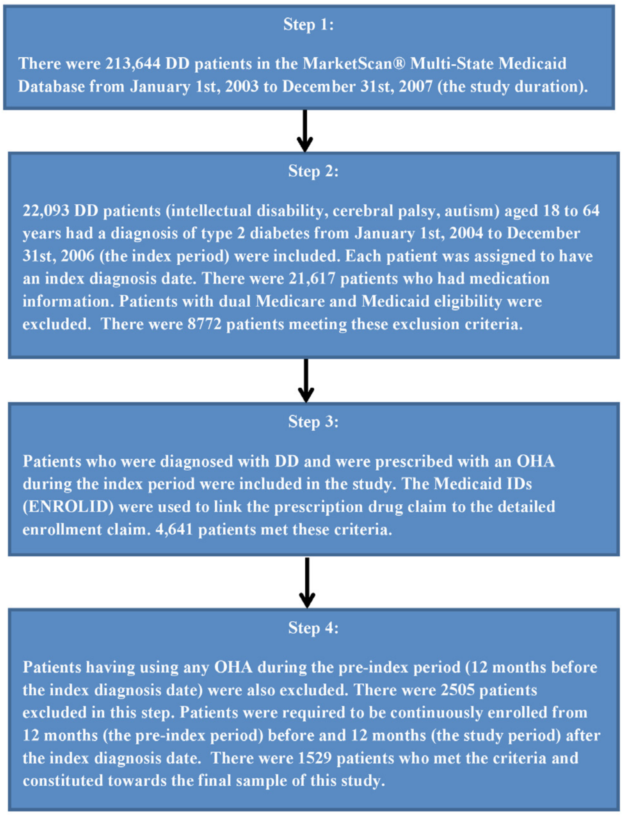

Figure 1 The analytic framework of obtaining the study population.

Our study found that patients with DD and type 2 diabetes enrolled in capitated Medicaid plans had higher healthcare utilization compared to patients with DD and type 2 diabetes, enrolled in FFS Medicaid plans. These findings were similar to a previous study conducted in a similar population without DD. Medicaid enrollees have very low copayments and out of pocket expenditures ($1-$3) for most of the services. Patients in capitated plans have limited prescription drug benefits due to presence of a cap on medication expenses. Out of pocket expenditures increase once the cap is reached. In capitated plans, reduced adherence, inadequately provided health services, shorter treatment periods, limited patient follow up, and poor treatment can contribute to higher healthcare utilization.[50-52]

This study showed that higher medication adherence was associated with lower medication costs and overall costs. Also, African Americans had higher medication and overall healthcare costs compared to Caucasians. These results were similar to previous research conducted by Anderson et al.,[32-35] which found that 10% increase in medication adherence to pioglitazone in type 2 diabetes patients led to 2% decrease in total healthcare costs and 4% decrease in diabetes related healthcare costs respectively.[53] Reichard and Stolzle,[13] conducted a retrospective study using the 2006 Medical Expenditures Panel Survey (MEPS) data and found that diabetic individuals with cognitive limitations had higher healthcare costs by $8,358 compared to non- diabetic individuals without cognitive limitations. Also, compared to non-diabetic individuals with no cognitive limitations, diabetic individuals with cognitive limitations incur 3.5 times more healthcare costs. Participation in diabetes management programs can lower healthcare costs among general public. Such programs should also be encouraged in diabetic individuals with intellectual disabilities. Health promotion programs including preventive health screenings, diet and exercise counseling, peer coaching and motivational interviewing should be conducted at workplace of caregivers of diabetic people with intellectual disabilities to improve their healthcare practices and knowledge. This can influence diabetes management and reduce diabetes related costs among diabetic individuals with intellectual disabilities.[13]

The study has a few limitations. Causation cannot be attributed due to the observational nature of the study. Variables such as beliefs, attitudes or intentions that are associated with healthcare utilization were not captured in this study. The study does not represent the people enrolled in Medicare, commercial insurers or dual eligibles. Claims data also does not have clinical measures such as HbA1c levels which are a measure of diabetes severity level. Hence, the healthcare utilization in the pre-study period was used as a proxy to determine the severity of type 2 diabetes. While information about primary and specialized care can be obtained from the claims dataset, collaboration between different types of providers for a particular patient or patient satisfaction cannot be measured. In case of developmentally disabled individuals, coordination of care can reduce hospitalization.[54-56] Claims dataset cannot capture variables for which reimbursement is not possible such as care coordination provided by social workers or the extent of caregiving provided by family members. The dataset used for this study is from 2003-2007. The recent version of the dataset could not be used due to budget restrictions. It is possible that the results might vary with the latest data.

This study provides important implications for health policy and research. Previous research on healthcare access in minorities shows that minorities tend to drop out more from community programs, receive fewer comprehensive services, lack access to trained culturally competent or bilingual healthcare providers, and are more underserved.[57] Verbal and non-verbal communication between physicians and patients can impact patient satisfaction, medication adherence and health outcomes. The distrust displayed by minority patients towards Caucasian physicians and healthcare institutions is rooted in their historical treatment by these institutions, physicians' discriminatory behavior, and biased treatment decisions imparted by physicians.[58] Non-verbal physician disengagement towards African American patients is characterized by more dominant behavior, less positive affect and less patient centered decision making.[59,60] When physicians are more engaged, minority patients may experience more satisfaction and therefore physicians can elicit more accurate medical information from them. Emotional expression, making eye contact and being comfortable during a conversation can differ based on a patient's cultural and ethnic background.[58,61] It is important for physicians to understand minority patients' non-verbal behavior by engaging in exercises to identify emotions on minority patients' faces and receiving feedback accordingly.[62] For physicians to change their non-verbal behavior towards minorities, interventions that target stereotypes and reduce their concerns about appearing prejudiced are needed. This would include unlearning bias, observing more interracial interactions, and counteracting negative stereotypes about racial minorities using mock interviews during medical training. Lastly, negative effects of racial bias and non-verbal communication can be counteracted by physicians by spending more time with minority patients during an examination visit, asking them to describe their health condition in their own words and displaying diversity reflecting messages in the waiting area.[58] Access to local outpatient healthcare facilities, continuous care and culturally competent healthcare providers who accept Medicaid patients could potentially reduce inpatient visits and emergency room visits in racial minorities. From an international perspective, evidence-based guidelines for people with DD should be designed and health policies that can enforce these guidelines should be in place. Eliminating the burden of out-of-pocket costs and making public health programs and health insurance premiums affordable can benefit people with DD who are in a lower SES bracket. Incentivizing providers for comprehensive care, training caregivers and community workers and promoting community-based rehabilitation can improve access to services and care coordination for people with DD. DD focused education should be incorporated in the health professions curriculum for students and continuing education should be provided to providers.[63] Future studies could be conducted in DD adults with diabetes who are uninsured or have Medicare or dual eligibility or commercial insurance. Studies can also be replicated in DD adults with other chronic disease conditions. Along with analyzing claims data, data should also be collected via survey instruments or focus groups to understand the medication intake beliefs, attitudes, and intentions among different racial minorities. Research about access to quality care with a focus on care coordination, extent of caregiving, degree of patient independence and adherence to evidence based prescribing practices in people with DD can be conducted.

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Conflicts of interest

Authors declare there is no conflicts of interest.

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