The Impact of Long-Acting Medications on Attention-Deficit/Hyperactivity Disorder Treatment Disparities

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Abstract

Objective: Long-acting stimulants have increased medication adherence for many children diagnosed with attention deficit/hyperactivity disorder (ADHD), but it is unknown whether the increase has been similar across racial/ethnic groups. Our objective was to determine whether differences in medication utilization and adherence among white, black, and Hispanic ADHD-diagnosed children and adolescents narrowed following the introduction of long-acting stimulants in the 1990s.

Methods: We conducted a retrospective analysis of Florida Medicaid claims data from fiscal years 1996–2005. At each of three cross sections, we identified children and adolescents 3–17 years of age with at least two claims with an ADHD diagnosis. We used linear regression to model disparities over the study period in utilization of any ADHD medications (utilization of long-acting medication specifically) and medication adherence, and identified patient level, treatment setting, and geographic contributors to disparities.

Results: Although ADHD medication utilization was lower for ADHD-diagnosed minorities than whites in all years, minorities were as likely as whites to switch to long-acting medications. The increase in prescribed days following long-acting medication diffusion was comparable for white and black medication users (40 and 43 days, respectively), but lower for Hispanics (27 days). Geography and provider setting helped to explain disparities in medication utilization overall, but disparities in adherence were not explained by any of the covariates.

Conclusions: Despite equivalent switching to long-acting medications in the study period, minorities continued to utilize all ADHD medications less than did whites, and for shorter periods. Provider setting helps explain the ADHD medication utilization gap. High-volume, minority-serving providers are potential targets for future interventions related to improved communication about medication and follow-up after medication initiation.

Introduction

LONG-ACTING FORMULATIONS OF stimulant medications have been the fastest growing pharmacotherapy among children diagnosed with attention-deficit/hyperactivity disorder (ADHD) since the late 1990s (Fullerton et al. 2012). These medications have displaced shorter-acting treatments that require two or more daily administrations (Stein 2004). Simplifying medication treatment makes it easier to establish a treatment routine, leading to more habitual and automatic use (Chacko et al. 2010). Long-acting medication users have shown increased adherence compared with short-acting users (Adler and Nierenberg 2010). Whereas long-acting medications offer broad benefits to all children diagnosed with ADHD, their impact on racial/ethnic disparities is unknown. Black and Hispanic children with an ADHD diagnosis are less likely to utilize stimulant medi-

cations than are non-Hispanic whites (Winterstein et al. 2008; Chen et al. 2009) and those that initiate treatment are more likely to discontinue treatment (Marcus et al. 2005).

In theory, new technologies that simplify treatment could disproportionately benefit minorities and reduce disparities in outcomes (Goldman and Lakdawalla 2005). Factors that contribute to low medication adherence, such as dysfunctional schools, irregular parental work schedules, and lower social support, are prevalent among minority children with ADHD (Bussing et al. 2003; Guevara et al. 2005). Literature on ADHD medication use among minorities emphasizes cultural norms that contribute to lower medication adoption (dosReis et al 2006; Eiraldi et al. 2006), yet it is also likely that some minority families are willing to start a child on medication but fail to continue treatment because of difficulty adhering to the treatment regimen. By simplifying dosing

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schedules, new treatments can reduce the social and environmental stressors that lead to nonadherence.

On the other hand, treatment innovations could increase disparities. Because of better access to care, whites often adopt new medications before blacks and Hispanics for many conditions (Lleras-Muney and Lichtenberg 2002). This could be explained by numerous factors. Minority children are more likely to reside in medically underserved communities and to receive treatment from community clinics (Galbraith et al. 2010). Providers serving minority children with ADHD have reported that they were overburdened and not able to keep abreast of the latest developments in treatment (Guevara et al. 2005). Geographic segregation may reinforce disparities, as mental health treatments diffuse through peer groups of providers (Gotham 2004). In addition, exposure to direct-to-consumer pharmaceutical advertising is higher among whites than minorities (Avery et al. 2008), which could lead to greater demand for new medications.

In this study we use Medicaid claims from fiscal years (FYs) 1996–2005 to examine disparities in medication utilization and adherence following the introduction of long-acting medications among a diverse population of children and adolescents in Florida. We address three questions. First, were minorities initially less likely than whites to receive long-acting medications, and if so, did the gap narrow with time? Second, can we explain the racial/ethnic utilization gap by adjusting for demographic, geographic, and provider-level factors? Finally, what were the implications of long-acting medication diffusion for adherence? We test two hypotheses: that minorities would be slower to adopt long-acting medications than whites because of geographic and provider-level barriers, and that minorities who adopted long-acting medications would increase adherence even more than whites because the medications address barriers to adherence common among minorities.

Methods

Using Medicaid claims, we created cross-sectional cohorts of children and adolescents. We included subjects in a cross-sectional cohort if they were between the ages of 3 and 17 and had two or more claims with an ADHD diagnosis (International Classification of Diseases, 9th revision [ICD-9]: 314xx) during that particular year. We excluded those enrolled in a health maintenance organization, because we would not have access to their complete utilization data. We also excluded those who had pervasive developmental disorders, mental retardation, or schizophrenia. Our total sample included 142,625 children and adolescents. During this period, roughly half of the Florida program was fee-for-service (50% of the child and adolescent population was in managed care in FY 1999, increasing to 59% by FY 2005 [authors' analysis of Medicaid Statistical Information System 2012]). ADHD medication prescriptions were not subject to prior authorization.

Outcome variables

Our two main outcomes were utilization of ADHD medication treatment and medication adherence. We counted subjects as utilizing an ADHD medication if they filled at least one prescription for either long-acting ADHD medication (stimulants or atomoxetine) or short-acting stimulants. Subjects with filled prescriptions for both types were placed in the long-acting group. We divided the remaining subjects into individuals with prescriptions for other psychotropics (such as atypical antipsychotics, alpha agonists, and antidepressants) and individuals without prescriptions for psychotropics.

We measured adherence as the total number of days in the year after the first prescription with a filled ADHD medication prescription. We summarize adherence with the continuous measure “annualized prescribed days” (APDs), calculated by dividing the days with prescribed medications by total days after the first prescription and then multiplying by 365.

Independent variable

Using a combined measure of race/ethnicity created by the Florida Medicaid program, we divided the study population into white, black, and Hispanic groups. The latter group combines children classified in the Hispanic category with the “other/missing” category because the Hispanic category was only adopted after 1999 in the Supplemental Security Insurance (SSI) program, and we, therefore, cannot accurately identify Hispanic subjects who enrolled through SSI in earlier years.

Individual covariates

We grouped children into age categories and included an indicator for sex. We included an indicator for the eligibility category of each subject: income-eligible subjects under now-outdated Aid to Families with Dependent Children (AFDC) standards, subjects with disabilities eligible through SSI, and “other” eligibility. Using ICD-9 codes, we identified the presence of mental and physical health comorbidities.

Treatment providers

Approximately 92% of subjects in the sample with diagnosed ADHD had a claim for ADHD treatment from a prescriber (the remainder only visited non-prescribing therapists or school counselors). Using a specialty code, we classified prescribers as psychiatrists and primary care physicians (PCPs). We assigned subjects to a primary PCP, a primary psychiatrist, or both, defined as the psychiatrist (or PCP) who had the most number of visits with the subject for ADHD treatment (or the greatest dollar amount in claims if two providers had an equal number of visits).

Region

The Florida Medicaid program divides the administration of the state program into 11 regions, consisting of between 1 large urban county (Broward County) and 12 adjoining rural counties. These divisions correspond to distinct regions or metropolitan areas.

Descriptive analysis

We present unadjusted descriptive statistics separately for whites, blacks, and Hispanics in 2 year cross-sections at the beginning and the end of the study period: FYs 1996–1997 and 2004–2005 (an intervening cross-section, FYs 2000–2001, is included in regression analyses). We display demographic characteristics stratified by race/ethnicity and time point, as well as the unadjusted percentages of subjects utilizing ADHD medications, and measures of adherence (APDs). We calculated χ^2 statistics for pairwise white–black and white–Hispanic differences, and for differences between the first and third periods.

To study ADHD medication utilization differences at the level of individual providers, we also calculated the percentage of subjects in each group filling prescriptions at each of the 200 highest-volume providers. We display these results in scatterplots

overlaid with the percentage of whites at each provider receiving medications on the x-axis and the percentage of black (or Hispanic) subjects receiving medications on the y-axis. The size of each dot is proportional to the number of minority children and adolescents visiting the practice. We overlay a weighted line of correlation.

Regression analysis

Using the complete pooled data, we estimated staged ordinary least squares regression models for three study outcomes: 1) the probability of utilizing any ADHD medication, 2) the probability of utilizing long-acting medications specifically, and 3) number of APDs. In our first model we included indicators for racial/ethnic group, time period, and their interaction. We then sequentially added covariates for clinical and demographic characteristics, region, and treatment setting to see whether these variables explained racial/ethnic disparities. In our final specification, we included a fixed effect for primary psychiatrist, PCP (where there was no psychiatrist), or an indicator for “no provider,” for the small group without prescriber visits. By controlling directly for prescribers, we could evaluate whether differences between whites and minorities were explained by within-provider prescription utilization patterns. Specifically, if patients of all races/ethnicities filled prescriptions at the same rate conditional on provider, we would expect the race/ethnicity coefficients to remain unchanged, but any attenuation of the race/ethnicity coefficient would indicate within-prescriber prescription filling differences.

Results

Demographic trends by race/ethnicity

Table 1 provides descriptive statistics of the ADHD cohort for the first time period (FYs 1996–1997) and the final period (FYs 2004–2005) stratified by race/ethnicity. The number of children and adolescents diagnosed with ADHD in Florida fee-for-service Medicaid increased rapidly during the 10 year period, especially for Hispanics, among whom the number of diagnosed children and adolescents more than tripled.

There were considerable variations in demographics characteristics and health conditions between whites and minorities at each time period, especially when comparing white and Hispanic subjects. Hispanic subjects were significantly more likely to be male and to be in the youngest age group (especially in period 1). Over time, however, the age distribution for all groups of diagnosed subjects shifted toward older youth, and females became a slightly higher proportion of the diagnosed population, which remained >70 male in all groups.

White diagnosed subjects were most likely to be eligible for Medicaid through the AFDC category at both periods, followed by blacks, and finally Hispanics. Conversely, at period 1, almost half of the Hispanics enrolled through the SSI category; this contrasts with one quarter of whites and one third of blacks. The proportion of SSI-category subjects declined over time for whites and blacks, but not Hispanics. Notably, this time period coincides with an expansion of income eligibility for Medicaid for children, as well as a phasing out of ADHD as an SSI-qualified disability (Mayes et al. 2009).

TABLE 1. DEMOGRAPHICS OF ADHD COHORTS BY RACE AND TIME PERIOD

	FYs 1996–1997			FYs 2004–2005		
	White n (%)	Black n (%)	Hispanic n (%)	White n (%)	Black n (%)	Hispanic n (%)
Age (total)	16008	10242	6849	25193	15080	23003
3–8	5669 (35.4%)	3872 (37.8%) ^a	3514 (51.3%) ^a	8041 (31.9%) ^b	4772 (31.6%) ^{a,b}	7893 (34.3%) ^{a,b}
9–13	8202 (51.2%)	5285 (51.6%)	2712 (39.6%)	11488 (45.6%)	7169 (47.5%)	11034 (48%)
14–17	2137 (13.4%)	1085 (10.6%)	623 (9.1%)	5664 (22.5%)	3139 (20.8%)	4076 (17.7%)
Sex						
Male	12503 (78.1%)	7788 (76%) ^a	5556 (81.1%) ^a	18011 (71.5%) ^b	10793 (71.6%) ^b	17678 (76.9%) ^{a,b}
Medicaid eligibility						
AFDC	11904 (74.4%)	6813 (66.5%) ^a	3448 (50.3%) ^a	22805 (90.5%) ^b	11144 (73.9%) ^{a,b}	11804 (51.3%) ^a
SSI	4019 (25.1%)	3413 (33.3%)	3387 (49.5%)	2289 (9.1%)	3919 (26%)	11125 (48.4%)
Other	85 (0.5%)	16 (0.2%)	14 (0.2%)	99 (0.4%)	17 (0.1%)	74 (0.3%)
MH comorbidities						
No MH comorbidity	10116 (63.2%)	6725 (65.7%) ^a	4519 (66%) ^a	13457 (53.4%) ^b	8222 (54.5%) ^{a,b}	12741 (55.4%) ^{a,b}
Bipolar disorder	470 (2.9%)	171 (1.7%)	165 (2.4%)	2109 (8.4%)	577 (3.8%)	1319 (5.7%)
Externalizing disorder	2299 (14.4%)	1838 (18%)	915 (13.4%)	3782 (15%)	3029 (20.1%)	3268 (14.2%)
Depression	907 (5.7%)	513 (5%)	360 (5.3%)	1218 (4.8%)	730 (4.8%)	1049 (4.6%)
Adjustment disorder	1349 (8.4%)	589 (5.8%)	301 (4.4%)	1910 (7.6%)	1049 (7%)	914 (4%)
Other diagnosis	867 (5.4%)	406 (4%)	589 (8.6%)	2717 (10.8%)	1473 (9.8%)	3712 (16.1%)
Physical comorbidities						
Asthma	855 (5.3%)	428 (4.2%)	720 (10.5%) ^a	2398 (9.5%) ^b	1372 (9.1%) ^b	3131 (13.6%) ^{a,b}
Diabetes	38 (0.2%)	19 (0.2%)	23 (0.3%)	98 (0.4%)	38 (0.3%)	106 (0.5%)
Obesity	41 (0.3%)	30 (0.3%)	40 (0.6%)	279 (1.1%)	187 (1.2%)	413 (1.8%)
ADHD treatment						
Psychiatrist only	7838 (49%)	6425 (62.7%) ^a	3757 (54.9%) ^a	8145 (32.3%) ^b	7425 (49.2%) ^{a,b}	10351 (45%) ^{a,b}
PCP only	4705 (29.4%)	2096 (20.5%)	1628 (23.8%)	11095 (44%)	3660 (24.3%)	6011 (26.1%)
PCP and psychiatrist	3214 (20.1%)	1504 (14.7%)	1286 (18.8%)	3187 (12.7%)	1825 (12.1%)	3793 (16.5%)
Non-prescriber only	251 (1.6%)	217 (2.1%)	178 (2.6%)	2766 (11%)	2170 (14.4%)	2848 (12.4%)

^aSignificantly different than whites in time period at $p < 0.0001$.

^bSignificantly different for race/ethnicity compared with 1996–1997 at $p < 0.0001$.

ADHD, attention-deficit/hyperactivity disorder; AFDC, Aid to Families with Dependent Children; SSI, supplemental security insurance.

There were some significant differences by race in diagnosed comorbidities at both time periods. Externalizing disorders were the most common psychiatric comorbidity, especially among blacks. Whites were more likely to have diagnosed bipolar disorder, depression, or adjustment disorder. Hispanics had double the rate of diagnosed asthma of white subjects in the initial period. The diagnosed prevalence of comorbidities such as bipolar disorder, asthma, and obesity increased in all groups over time.

Finally, most subjects were likely to have received care from a psychiatrist, either exclusively, or in combination with some care from a PCP. White subjects were much more likely to receive care exclusively from a PCP compared with minorities. The proportion of subjects treated exclusively by a PCP also increased over time, especially for whites, which went from ~29% to 44%.

Medication utilization and adherence trends by race/ethnicity

Table 2 displays the rates of medication use and mean APDs stratified by race/ethnicity and time period. Blacks were twice as likely as whites to not receive medication at each time point, and Hispanics were 1.75 times as likely. The proportion of subjects who remained unmedicated decreased in all groups between periods 1 and 3, but the decline was not significant for Hispanics. There was more than a sixfold increase in the share of subjects in each group using long-acting medications, and a commensurate decline in the share using other medications. For example, whereas 11% of whites used long-acting medications in period 1, the proportion increased to 71% by period 3. Whites were more likely than minorities to adopt long-acting medications overall, but there was no gap in adoption when considering only those who used medication in each time period.

The bottom portion of Table 2 displays mean APDs for ADHD medication users only, and then subdivides this into long- and

short-acting medication users. The table also displays APDs averaged across all subjects in each group, calculated by imputing a value of zero treatment days for those without any filled prescriptions, and then averaging between treated and untreated subjects. When considering the broadest measure of APDs averaged across all subjects, APDs were highest for whites at baseline (141 days) and lowest for blacks (87 days) followed by Hispanics (106 days). Over the study period, average gains in APDs across all subjects were much greater for whites (43 days, compared with 34 days for blacks and 27 days for Hispanics), a finding explained by the lower use of medications among minorities in both periods. This pattern persisted when considering only those with ADHD medications. All groups of subjects with ADHD medication substantially increased APDs over the study period, and the gains were roughly comparable for whites and blacks (40 and 43 days, respectively), but substantially lower for Hispanics (27 days). Finally, considering only those using long-acting medications, we found that they had the highest unadjusted APDs in all groups, and again, mean APDs were highest for whites in both time periods.

Provider-level analysis

Figure 1 depicts white-black average rates of ADHD medication utilization between- and within-providers for the 200 highest-volume providers over the study period. These providers accounted for 5% of all providers ($n=4011$) serving Medicaid-enrolled children and adolescents with an ADHD diagnosis during this period, but they collectively saw 66% of ADHD-diagnosed children and adolescents with visits to a prescriber. Figure 2 illustrates white-Hispanic rates of ADHD medication utilization for the same 200 providers. The sizes of the bubbles in the figures indicate the relative size of each provider's minority caseload. The figures show that the providers with the largest minority caseloads tended to have the lowest utilization rates for all children and adolescents. For

TABLE 2. MEDICATION USE RATES AND AVERAGE ANNUALIZED PRESCRIBED DAYS (APDs) BY RACE AND TIME PERIOD

	FYs 1996–1997			FYs 2004–2005		
	White n (%)	Black n (%)	Hispanic n (%)	White n (%)	Black n (%)	Hispanic n (%)
<i>Medication use rates</i>						
Full sample						
Long-acting medications	1747 (10.9%)	569 (5.6%) ^a	540 (7.9%) ^a	17779 (70.6%) ^b	7894 (52.4%) ^{a,b}	13047 (56.7%) ^{a,b}
Short-acting medications	9249 (57.8%)	4551 (44.4%) ^a	3242 (47.3%) ^a	1096 (4.4%) ^b	489 (3.2%) ^{a,b}	911 (4%) ^b
Other psychotropics only ^c	1423 (8.9%)	651 (6.4%) ^a	624 (9.1%)	1343 (5.3%) ^b	599 (4%) ^{a,b}	1088 (4.7%) ^b
No psychotropics	3589 (22.4%)	4471 (43.7%) ^a	2443 (35.7%) ^a	4975 (19.8%) ^b	6098 (40.4%) ^{a,b}	7957 (34.6%) ^a
Medication users only						
Long-acting medications	1747 (14.1%)	569 (9.9%) ^a	540 (12.3%)	17779 (87.9%) ^b	7894 (87.9%) ^b	13047 (86.7%) ^b
Short-acting medications	9249 (74.5%)	4551 (78.9%) ^a	3242 (73.6%)	1096 (5.4%) ^b	489 (5.4%) ^b	911 (6.1%) ^b
Other psychotropics only	1423 (11.5%)	651 (11.3%)	624 (14.2%) ^a	1343 (6.7%) ^b	599 (6.7%) ^b	1088 (7.2%) ^b
	FYs 1996–1997			FYs 2004–2005		
	White	Black	Hispanic	White	Black	Hispanic
Full sample	141.2	87.3 ^a	105.8 ^a	183.9 ^b	121 ^{a,b}	133.1 ^{a,b}
ADHD med users only	205.5	174.7 ^a	191.6 ^a	245.4 ^b	217.7 ^{a,b}	219.2 ^{a,b}
Short-acting med users only	202.5	172.2 ^a	188.1 ^a	213.6	181.5 ^a	191.6 ^a
Long-acting med users only	221.7	194.4 ^a	213 ^a	247.4 ^b	219.9 ^{a,b}	221.2 ^a

^aSignificantly different than whites in time period at $p < 0.0001$.

^bSignificantly different for race/ethnicity compared with 1996–1997 at $p < 0.0001$.

^cOther psychotropics are non-stimulant medications such as alpha agonists, antidepressants, and atypical antipsychotics. The one exception is atomoxetine, which is classified with long-acting medications.

ADHD, attention-deficit/hyperactivity disorder.

FIG. 1. Black–white rates of medication use at the provider level (all years). Each bubble represents a single provider. Bubbles are weighted to the number of minority children visiting the provider during the study period.

example, fewer than half of the white and Hispanic children and adolescents at the largest Hispanic-serving provider filled prescriptions during the study period.

The white–black correlation line lies substantially below the 45 degree line, indicating large differences in average filled prescription rates between blacks and whites seeing the same provider (Figure 1). The white–Hispanic correlation line (Figure 2) lies close to the 45 degree line (the 95% confidence interval almost includes the 45 degree line), suggesting that although there were large unadjusted differences among providers, whites and Hispanics were filling prescriptions at similar rates, conditional on seeing the same providers.

Regression models

Table 3 presents the estimated black–white and Hispanic–white disparities in each period for three outcomes: Probability of using any ADHD medication, probability of using long-acting medications specifically, and average APDs. These estimates were derived from linear regression models that pooled together all three cross sections and included main effects for race and time, race by time interactions, and covariates.

The coefficients in the table represent the average black–white and Hispanic–white differences after adjusting for other covariates. We indicate whether the estimated gap at baseline, and the change in the gap between baseline and periods 2 or 3 were statistically significant ($p < 0.001$).

Disparities in use of any ADHD medications. The unadjusted black–white disparity in any ADHD medication use was approximately 19 percentage points in period 1 (Model 1). This gap widened slightly to 22 points in period 2, but narrowed again by period 3. Adjustment for individual-level factors (Model 2) did not explain any of the gap, but controlling for region (Model 3), service setting (Model 4), and provider fixed effects (Model 5) each substantially explained a portion of the utilization disparities in each of the treatment years. For example, adjusting for all of these factors reduced the period 1 gap to 8 percentage points (almost two thirds of the unadjusted estimate). The Hispanic–white disparity in any ADHD medication use was substantial in period 1 (14 percentage points), and widened slightly in period 2 (16 points) before narrowing in period 3 (back to 14 points). As with whites, adjusting for individual-level factors did not attenuate the gap, but geography and providers accounted for more than three quarters of the gap. Adjusting for geography narrowed the period 1 gap to 6 points, and full adjustment further reduced the gap to 2 percentage points. Hispanics were disproportionately concentrated in south Florida, where medication use rates were lowest on average for all groups.

Disparities in use of long-acting medications. The next set of models examined disparities in the use of long-acting medications overall in the population. The unadjusted overall gap in use of long-acting medications widened over time: The black–white gap increased from 5 to 18 percentage points. It is important to

FIG. 2. Hispanic–white rates of medication use at the provider level (all years). Each bubble represents a single provider. Bubbles were weighted to the number of minority children visiting the provider during the study period.

remember that these estimates reflect unconditional differences in the diagnosed population. As was illustrated in Table 2, there was only a modest gap in the probability of adopting long-acting medications *conditional on using any ADHD medications*. Adjustment for individual-level factors (Model 2) did not help explain the black–white gap in use of long-acting medications. However, adjustment for geography, treatment setting, and provider fixed effects jointly reduced the black–white gap by more than one half in all periods. The basic pattern was similar for the Hispanic–white gap. After full adjustment, the Hispanic–white gap was actually reversed in the baseline period, and reduced by almost two thirds for FYs 2004–2005 (decreasing the gap from 14 percentage points to 5 percentage points). The large attenuating effect of geography and provider setting suggest that segregation in where children are living, and which providers they visit, are important contributors to medication use differences.

Disparities in APDs. Finally, when focusing on the black–white gap in mean APDs, we find substantial average unadjusted disparities (~30 days) in period 1, which remained fairly constant across the study periods. Adjustment for individual-level factors and region did not explain much of the gap. In Model 4, we adjusted for provider setting, and also included an indicator for whether the patient was using a long-acting medication. This further adjustment only very slightly attenuated the estimated black–white gap (by ~2 days). Including provider fixed effects in Model 5 slightly reduced

the black–white gap. The baseline Hispanic–white gap was smaller (14 days), but increased to 26 days by period 3. Adjusting for the same set of factors substantially explained the gap only for the final period. In period 3, the provider fixed effect explained one quarter of the difference, suggesting that Hispanic children were shifting to settings where APDs were lower on average.

Discussion

This study examined changes in utilization of long-acting medications for ADHD and medication adherence among a diverse population of children and adolescents in the Florida Medicaid program. We found that black and Hispanic subjects had much lower initial prescription filling rates than did white subjects, and the gap did not narrow. Use of long-acting medications increased more than sixfold in all groups. Minorities had a lower probability of utilizing long-acting medications in every time period, but conditional on using an ADHD medication, white and minority subjects were equally likely to switch to long-acting medications. A combination of geographic and provider-level factors largely explained the lower utilization of ADHD medications among minorities.

One striking finding was that most of the children and adolescents with ADHD in the Florida Medicaid program received their care primarily from a few providers with very large panels of Medicaid children and adolescents. The 200 highest-volume providers were the primary providers for 66% of all ADHD-diagnosed

TABLE 3. DISPARITIES ESTIMATES FOR ADHD MEDICATION USE, LONG-ACTING USE, AND MEAN ANNUALIZED PRESCRIBED DAYS (APDs) BY TIME PERIOD

Outcome	Disparity	Period (FY)	Model 1		Model 2		Model 3		Model 4		Model 5	
			Unadjusted		Individual-level (Comorbidities, Age, Sex)		Individual-level and region		Individual-level, region, service setting ^c		Individual, region, service setting, provider fixed effects	
			Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Any attention-deficit-hyperactivity disorder (ADHD) medication use	Black-White	1996–97	-0.187 ^a	0.006	-0.191 ^a	0.006	-0.148 ^a	0.006	-0.108 ^a	0.005	-0.080 ^a	0.006
		2000–01	-0.220 ^b	0.008	-0.228 ^b	0.008	-0.173	0.008	-0.127	0.007	-0.099	0.007
	Hispanic-White	2004–05	-0.193	0.008	-0.202	0.008	-0.144	0.008	-0.083 ^b	0.007	-0.059	0.007
		1996–97	-0.135 ^a	0.007	-0.154 ^a	0.007	-0.058 ^a	0.007	-0.048 ^a	0.006	-0.023 ^a	0.007
		2000–01	-0.160	0.009	-0.192 ^b	0.009	-0.094 ^b	0.008	-0.062	0.008	-0.042	0.008
Long-acting ADHD medication use	Black-White	2004–05	-0.142	0.009	-0.174 ^b	0.009	-0.072 ^b	0.008	-0.040	0.008	-0.024	0.008
		1996–97	-0.054 ^a	0.006	-0.055 ^a	0.006	-0.026 ^a	0.006	0.000	0.005	0.008	0.006
	Hispanic-White	2000–01	-0.137 ^b	0.008	-0.141 ^b	0.007	-0.105 ^b	0.007	-0.078 ^b	0.007	-0.062 ^b	0.007
		2004–05	-0.182 ^b	0.007	-0.186 ^b	0.007	-0.147 ^b	0.007	-0.107 ^b	0.007	-0.076 ^b	0.007
		1996–97	-0.030 ^a	0.006	-0.039 ^a	0.006	0.019	0.007	0.027 ^a	0.006	0.032 ^a	0.006
Mean APDs (among ADHD medication users)	Black-White	2000–01	-0.092 ^b	0.008	-0.110 ^b	0.008	-0.048 ^b	0.008	-0.029 ^b	0.008	-0.016 ^b	0.008
		2004–05	-0.138 ^b	0.008	-0.157 ^b	0.008	-0.090 ^b	0.008	-0.070 ^b	0.008	-0.046 ^b	0.008
	Hispanic-White	1996–97	-30.80 ^a	1.59	-32.38 ^a	1.58	-29.03 ^a	1.58	-26.75 ^a	1.57	-24.58 ^a	1.66
		2000–01	-30.33	2.12	-32.05	2.10	-28.60	2.09	-27.43	2.07	-25.54	2.15
		2004–05	-27.73	2.01	-29.68	2.00	-25.77	1.99	-25.21	1.97	-23.04	2.08
	Hispanic-White	1996–97	-13.88 ^a	1.77	-19.53 ^a	1.78	-12.35 ^a	1.81	-11.18 ^a	1.80	-10.51 ^a	1.91
		2000–01	-19.13	2.19	-26.60	2.18	-19.31	2.17	-18.71 ^b	2.15	-14.99	2.26
		2004–05	-26.17	2.19	-32.22	2.18	-23.77	2.17	-23.48 ^b	2.15	-18.17	2.26

^aDisparity in baseline period (FY 1996–1997) significant $p < .001$.^bChange in disparity significantly different than baseline (FY 1996–1997) $p < .001$.^cAlso includes a term for long-acting medication use for the APDs models.

Individual-level: sex, age, eligibility group, mental and physical health comorbidities; 11 Medicaid regions in Florida; service setting: primary care physician (PCP) only, psychiatrist only, PCP and psychiatrist, and no prescriber.

children and adolescents, and those receiving care from these providers were disproportionately Hispanic and black. Although our data do not include measures of visit length or patient satisfaction, the sheer volume of these patients being seen by a small group of providers raises questions about the ability of these providers to have meaningful office visits with their ADHD-diagnosed patients and their families. If minorities receive fewer follow-up visits and less information about ADHD medication, they may be more reluctant to fill prescriptions. Studies have highlighted that minority children and adolescents with ADHD are less likely to receive care in a medical home (Toomey et al. 2010), and that poor communication with providers is a specific concern among families of minority children with ADHD (Olaniyan et al. 2007).

In terms of adherence, we identified large and persistent racial/ethnic gaps in APDs at baseline. Although APDs increased among medication users in all three groups over the study period, black-white disparities did not narrow and Hispanic-white disparities widened. We could not explain any of this difference in terms of observable individual-level or provider-level factors. Exploring these differences is an important topic for future research. We speculate that it may partially be attributable to worse access to providers and pharmacies for minorities and culturally specific norms about medication use. It is also worth understanding how medication continuity and adherence may be influenced by use of non-medication therapies and behavioral interventions in the school setting. We did not specifically examine the use of other types of treatment, which may be used either as complements or as alternatives to medication therapy.

Limitations

Some study limitations should be noted. First, the sample was restricted to children and adolescents with paid claims for ADHD treatment, which excludes those who met the diagnostic criteria but were not adequately evaluated. If minority subjects were less likely than white subjects with similar symptoms to be diagnosed, this could understate disparities in treatment. In a national survey, however, minority children and adolescents with ADHD symptoms were as likely as whites to have been diagnosed (Froehlich et al. 2007). Another concern is that ADHD-diagnosed cohorts in earlier periods may be composed of children and adolescents with higher severity, as the diagnosis rate has expanded over time to cover more people. Higher severity of symptoms is associated with higher rates of ADHD medication utilization (Visser et al. 2007); therefore, cohort effects would tend to understate the increase in medication utilization. We attempt to address this by adjusting for comorbidities, but we lack direct measures of ADHD impairment. Second, because our study sample excluded children and adolescents enrolled in managed care, our results may not be generalizable to all children and adolescents with ADHD, particularly those with lower levels of impairment. The growth of managed care during the study period could introduce some sample selection bias, but is unlikely to have substantially influenced racial/ethnic disparities unless selection was different across racial/ethnic groups. Third, our measure of race/ethnicity was defined using administrative records, which have been shown to have higher sensitivity for categorizing whites and blacks than Hispanic ethnicity (Arday et al. 2000). Also, as already noted, we were not able to consistently identify Hispanic subjects among those in the "other/missing" category; therefore, this category included a small number of non-Hispanic subjects of other races. Other races comprised a small share of Florida's

population during the study period: only 2% of the population in Florida reported Asian, Native American, or Pacific Islander as their race in the 2000 Census (U.S. Census Bureau 2007). Finally, our results may not generalize to a national sample of ADHD-diagnosed Medicaid-enrolled children and adolescents. For example, we found that minorities were less likely to receive ADHD treatment in primary care than whites, but this pattern may not hold in other states.

Clinical Significance

Our study illustrates the persistence of medication treatment gaps between white and minority children and adolescents, even in the context of a public insurance program with no copayments or prior authorization for medication. In our data, we observed widely varying medication use patterns that are unlikely to be justified by underlying differences in clinical need or preferences for treatment. Geography and provider setting are important factors that we found to explain utilization of ADHD medications. The large concentration of patients receiving care from a few high-volume providers suggests that effectively targeted interventions could have a large impact on the quality of care of many children and adolescents with ADHD, especially racial/ethnic minorities. There are several approaches that can be used to improve quality and increase consistency of prescribing and medication use. One approach is to focus on prescribing patterns among providers. There are now promising results from primary care interventions for pediatric ADHD targeted at improving adherence to clinical guidelines and coordinating care among PCPs, specialists, and educators (Kelleher and Stevens 2009).

Beyond emphasizing consistent prescribing, another approach is to focus on communication among providers, patients, and their families. Helping providers to recognize how cultural and social context influences specific concerns and preferences for different groups can enable them to better tailor guidance to these families. More in-depth communication can also be supported through higher reimbursement for consultation. Providers have cited low reimbursement for consultation from Medicaid as a barrier to the delivery of high quality, patient-centered ADHD care (Pfefferle 2007). Empowering patients and their families to discuss their concerns, and providing support and follow-up over the long term could improve medication continuity, and contribute to the elimination of disparities.

Disclosures

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