Racial Disparities in Medicaid Asthma Hospitalizations

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abstract

BACKGROUND AND OBJECTIVES: Black children with asthma comprise one-third of all asthma patients in Medicaid. With increasing Medicaid coverage, it has become especially important to monitor Medicaid for differences in hospital practice and patient outcomes by race.

METHODS: A multivariate matched cohort design, studying 11 079 matched pairs of children in Medicaid (black versus white matched pairs from inside the same state) admitted for asthma between January 1, 2009 and November 30, 2010 in 33 states contributing adequate Medicaid Analytic eXtract claims.

RESULTS: Ten-day revisit rates were 3.8% in black patients versus 4.2% in white patients (P = .12); 30-day revisit and readmission rates were also not significantly different by race (10.5% in black patients versus 10.8% in white patients; P = .49). Length of stay (LOS) was also similar; both groups had a median stay of 2.0 days, with a slightly lower percentage of black patients exceeding their own state's median LOS (30.2% in black patients versus 31.8% in white patients; P = .01). The mean paired difference in LOS was 0.00 days (95% confidence interval, −0.08 to 0.08). However, ICU use was higher in black patients than white patients (22.2% versus 17.5%; P < .001). After adjusting for multiple testing, only 4 states were found to differ significantly, but only in ICU use, where blacks had higher rates of use.

CONCLUSIONS: For closely matched black and white patients, racial disparities concerning asthma admission outcomes and style of practice are small and generally nonsignificant, except for ICU use, where we observed higher rates in black patients.

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WHAT'S KNOWN ON THIS SUBJECT: Although racial disparities are known to exist in outpatient care of children with asthma, a close examination of disparities in care within the hospital, closely controlling for burden of disease, is less well known.

WHAT THIS STUDY ADDS: This report closely compares practice style and outcomes in black and white children in the Medicaid system hospitalized for asthma. After closely matching patients, we can better test for racial disparities in hospitalized Medicaid recipients.

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Asthma is the most prevalent chronic illness among children, and remains a leading cause of hospitalizations among children aged 1 to 15 years in the United States.[1] Inpatient and emergency department treatment account for about one-third of all pediatric asthma-related healthcare costs.[2] Although the population of children in the United States is 15% black,[3] blacks comprise one-fourth of Medicaid children[4] and represent over one-third of all Medicaid asthma admissions.[5] This study compares the outcomes and style of practice as measured by all-cause revisits,[6,7] readmissions, length of stay (LOS), and ICU use and days in the ICU across black and white Medicaid children in 33 states contributing evaluable data to the Medicaid Analytic eXtract (MAX) database.

We used a methodology focusing on multivariate matching[8–12] to compare similar patients on hospital style of practice and outcomes. Asthma admissions of black, non-Hispanic children were paired with white, non-Hispanic children, always enrolled in Medicaid within the same state, carefully matched on patient characteristics. Only by closely matching patients can we understand whether racial differences exist in the care provided to these hospitalized Medicaid recipients.

METHODS

This study was approved by the Institutional Review Board of The Children's Hospital of Philadelphia.

Patient Population and Definitions

Data were obtained from MAX, a database that contains state enrollment and claims data for children enrolled in Medicaid and the Children's Health Insurance Program. These data are collected as part of each state's Medicaid Management Information System, which is unique to the state's Medicaid program. To allow for federal monitoring of the Medicaid program at the national level, the Medicaid Management Information System data are transformed to a uniform database and submitted to the Center for Medicare & Medicaid Services (CMS) via the Medicaid and Children's Health Insurance Program Statistical Information System. We examined black, non-Hispanic and white, non-Hispanic patients ages 3 through 18 years admitted with asthma between January 1, 2009 and November 30, 2010.

Asthma was identified with the presence of specific *International Classification of Diseases, Ninth Revision* (ICD-9) codes as shown in Table 1. Variables we matched on included: age, sex, common chronic conditions, asthma-affecting diagnoses, National Heart, Lung, and Blood Institute diagnoses of concern,[13] predicted LOS, predicted use of the ICU, predicted likelihood of revisits within 30 days, a propensity score to be a black patient within that state, and asthma severity at admission based on a 6-month lookback of asthma medication history (see Table 1 and Supplemental Information, Section I). We used only the first asthma admission in the data set for each patient.

Defining Outcome and Practice Style Variables

Once state matches were complete, black and white patients were compared on the following primary variables: 30-day all-cause revisit rates,[6,7] LOS, and ICU use percentage. The event of a revisit was defined as either a visit to any acute care hospital emergency department, a readmission, or a death. We used all information within the MAX dataset that would indicate the occurrence of a death. Although deaths were exceedingly rare, we did not want to give any credit to a hospital if their patient died before discharge (thus benefitting from avoiding the possibility of a revisit); hence, our definition of revisit counts in-hospital deaths as a revisit on day 0 from discharge and death after discharge up to 30 days as a revisit and death at the time the event occurred. Other secondary variables of interest also reported were 10-day all-cause revisit rates, 10- and 30-day all-cause readmission rates, days in the ICU and in-hospital, and 30-day from admission mortality.

Statistical Analysis

Matching Methodology

The multivariate matching methodology paired black and white patients enrolled in Medicaid within the same state. This match answered multiple questions. Is there a different treatment style for black and white patients pooling all of the matched pairs for all of the states? Is there a difference within each state, considering states one at a time? When matching inside a state, we created the maximum number of matched pairs, whether that number was limited by the number of black or white patients. An individual state was required to have a minimum of 50 potential pairs to be included in across-state pooled analyses. State-level analyses required at least 100 potential pairs. If the quality of the match was poor within a state, a subset of matched patient pairs was obtained using optimal subset matching,[12,14] a multivariate matching method that discards a minimal number of patients subject to conditions on the quality of the matched pairs.

We performed our matches using the R package MIPMatch.[15–17] We choose a balanced match that minimized medical distance[8,9,18,19] between matched pairs within each state, defined using the Mahalanobis distance. Details concerning distances are provided in Supplemental Information, Section III.

To improve the quality of the matches, we used "near-fine balance,"[12,20–23] generally forcing balance within each state; this

TABLE 1 Study Definitions

Asthma Case Designation	
Principal Diagnosis *ICD-9*	Secondary Diagnosis *ICD-9*
Asthma: 493X	None required
Respiratory failure: 518.81 or 518.82	Asthma: 493X
Chronic Conditions (Based on 6-mo Lookback)	
Diabetes	250–250.91
Metabolic disorders	270–273.9, 275–275.9
Sickle cell anemia	282.41, 282.42
Other blood disorders	281–281.9, 282.0–282.40, 282.43–282.9, 283–284.9, 286–286.9, 288–288.9
Cerebral palsy	343.0–343.9
Neural degeneration and disease	330–330.9, 331–331.4, 334–334.2, 340, 341–341.9, 356–356.9
Muscular dystrophy	335–335.9, 359–359.9
Epilepsy and seizures	345–345.91, 780.3
Other respiratory	770.7
Congenital and other heart disease	393–398.9, 414–414.9, 416–416.9, 745–747.49
Enteritis and other digestive	555–555.9, 556–556.9, 579–579.9
Chromosomal anomalies	758.0–758.9
Cancer	140–208.9, 237.7–237.9, 240–246.9
Immunocompromised or HIV	279–279.9, 288.1–288.2, 042
Autoimmune disease	695.4, 710–710.9, 714–714.9, 720.0–720.9
Major organ disorder	070–070.9, 277–277.1, 571–572.8, 581–583.9, 585–587, 588–588.9
Mental retardation	315–315.9, 317–319
Congenital anomaly	740–742.9, 748–751.9, 756–756.9, 758–759.9
Allergy: general	V150.9
Allergy: peanut	V150.1
Allergy: food	V150.2, V150.3, V150.5
Allergy: seafood	V150.4
Obesity	278X
Allergic bronchopulmonary aspergillosis	518.6
Gastroesophageal reflux	530.81
Obstructive sleep apnea	327.23
Rhinitis chronic	472.0
Rhinitis allergic	477.0, 477.1, 477.2, 477.8, 477.9
Sinusitis chronic	473X
Sinusitis acute	461X
Acute Conditions (Diagnosis During Admission of Interest)	
Acute upper respiratory infection	465X
Acute otitis media	381.00, 381.01, 381.02, 381.03, 381.04, 381.05, 381.06
Pneumonia bacterial	481–482
Pneumonia viral	480
Pneumonia organism unspecified	486
Viral infection	079
Dehydration	276.51, E904.2

ensured that if black patients had, for example, a 20% rate of upper respiratory infection on admission, that their matched white patients also had an upper respiratory infection rate of 20% without requiring that each matched pair have the same upper respiratory infection status. It was always preferred that matches have the same patient and clinical characteristics, but for variables matched using near-fine balance, a mismatch was allowed if it could be counterbalanced in another matched pair so overall, the matched patient groups were similar on these characteristics via minimizing the Mahalanobis distance function. For 5 of 33 states with especially low numbers of asthma admissions, we allowed fine balance to be conducted across these states, although members of each matched pair were always from the same state. A mean constraint was introduced on severity score, number of inpatient, outpatient, and emergency department visits related to asthma in the previous 6 months, age, predicted probability of revisit within 30 days, predicted probability of ICU use, predicted LOS, and propensity score for being a black patient in that state. We also added a penalty to the Mahalanobis distance for differences in these same variables.

Testing Match Quality

It is important to check that the match quality is adequate. For each covariate examined, the black versus white differences in means as a fraction of the standard difference score (SDs), aiming for an absolute value of ≤ 0.2.[12,24,25] To determine whether matched covariates were sufficiently balanced, we used

the Wilcoxon rank sum test for continuous variables[26] and Fisher's exact test for binary variables.[27] Statistical tests used SAS 9.2 (SAS Institute, Inc, Cary, NC) for UNIX.[28]

All matching was completed without knowledge of outcomes, as suggested by Rubin.[29,30] By matching without knowledge of outcomes, researchers are prevented from selecting the most attractive of multiple analyses.

Outcomes Analysis

We attempted to answer 3 questions using these matches: (1) Is there a difference in outcomes or practice style (revisits, LOS, and ICU use) between black and white asthma patients pooled across states? (2) Is the difference between black and white patients the same across states? And lastly, (3) Do any individual states stand out with especially large differences between black and white patients after adjusting for multiple testing (examining multiple individual states)?

In our primary analysis, we compared revisit rates, LOS, and ICU use to what is typical in that state, not to what is typical nationally. For example, for the continuous variable LOS, in matched black–white pairs from the same state, the primary analysis asked whether a patient stayed longer than the median in that state, not longer than the national median. Secondary analyses looked at national medians and other percentiles.

For continuous outcomes for the first question, we used quantile tests[31,32] that determined whether each patient exceeded its own state's median or 90th percentile value, then, in effect, we used McNemar's statistic[27,31] to test the equality of black and white groups in exceeding this value. For binary variables, revisit rates, readmissions, and ICU use, we tested the difference between black and white patients using the McNemar statistic. For 10-day and 30-day postdischarge analyses, we used the paired Cox model, allowing for censoring.[33] We plotted time from discharge to a revisit event (or readmission event) using the Kaplan–Meier method.[34]

We also looked at the black minus white differences in LOS and days in the ICU using the median (and its related sign test), the mean (and its related paired *t* test), and using the Hodges–Lehmann estimate (and its related Wilcoxon signed rank test).[26] We report all 3 tests because the paired *t* test is destabilized by individual patients with extreme values. The Wilcoxon test is not destabilized by the tails of the distribution, unlike the *t* test, but it does take them into account, unlike the sign test.

To answer the second question, "Is the difference between black and white patients the same across states?" we applied the Kruskal–Wallis test to the matched pair differences for LOS and days in the ICU. For binary variables, revisits within 10 and 30 days, and ICU use, we applied an χ^2 test of independence to the 2 × 28 table of discordant pairs.[35]

Finally, when looking at states one at a time, we again used quantile tests, as above, but with a correction for testing many hypotheses about many states based on the Bonferroni–Holm method.[36] We controlled the familywise error rate at 5% in the 3 primary outcome (30-day revisits, median LOS, and ICU use) tests, testing 28 states on all 3 primary measures (84 = 28 × 3 tests).

RESULTS

Matching Quality

Data from Maine was not available, leaving 49 states plus the District of Columbia. Selecting only states that had at least 50 non-Hispanic, black and 50 non-Hispanic, white patients in the data set, we had 33 states available for analysis. For individual, state-level questions (questions 2 and 3), we limited the analyses to the 28 states with a minimum sample size of 100 potential matched pairs (Alabama, Arkansas, Arizona, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Missouri, Mississippi, North Carolina, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and Wisconsin). Each of these states was fine balanced one state at a time. For the pooled analyses (question 1), we included 5 additional states (Iowa, Kansas, Massachusetts, Nebraska, and Washington) for a total of 33 states, for which matches were conducted within the state but fine balanced simultaneously across the 5 states. For example, this means that a pair mismatched for "upper respiratory infection" in Alabama (one of the 28 stand-alone states) was counterbalanced by another pair in Alabama, but a pair similarly mismatched in Iowa (one of the 5 grouped states with smaller sample sizes) might be counterbalanced by a pair from Kansas (also one of the 5 grouped states). After excluding transfer-in patients, there were 36 961 patients and 11 981 possible pairs of patients (where possible pairs is the minimum number of either white or black patients). Of these possible pairs, matches were achieved in 11 079 or 92% of possible pairs using optimal subset matching of patients.[12,14]

The overall matching quality for the 33 states is reported in Table 2. This table displays the 57 covariates controlled in the match (see Supplemental Information, Section IV for full results on all matching variables). Columns compare matched black and white patients. Pooling 33 states, none of the 57 matched covariates differed significantly between the 2 patient groups, and no standardized difference exceeded 0.10 SDs.

Furthermore, looking at the states one at a time, in no state did any of the 57 matched variables exceed a standardized difference of 0.2, and no differences reached statistical significance.

Outcome Results

Question 1: Differences Across Matched Black and White Patients

We first asked the question, "Are there differences in outcomes and practice style across matched black and white patients?" Table 3 examines primary outcomes of revisit rates, LOS, and ICU use across the 11 079 matched pairs. In addition, secondary analyses are displayed, including readmission rates and mortality (both in-hospital and 30-day). The same patterns of significance were also observed for 60- and 90-day follow-up (see Supplemental Information, Section V).

The black patient 30-day revisit rate was 10.5% versus 10.8% in matched white patients ($P = .58$). Ten-day revisit and readmission rates and 30-day readmission rates also were not significantly different. We also provide data on outpatient use over time, showing that white patients displayed an elevated hazard compared with black patients at 10, 30, 60, and 90 days postdischarge (see Supplemental Information, Section V). Excluding pairs that did not have asthma as the principal diagnosis yielded similar results (see Supplemental Information, Section V), as did excluding pairs with cerebral palsy, neurodegenerative disorders, or muscular dystrophy (see Supplemental Information, Section V).

Figure 1 displays a Kaplan–Meier plot of time to revisit event and time to readmission for black and white patients. As can be seen, both racial groups look similar for revisit and readmission rates, with P values based on matched pair differences being insignificant for both outcomes ($P = .58$ and $P = .49$, respectively). In-hospital deaths were counted as events occurring at time 0 for both readmissions and revisits. Of note, when assessing 30-day mortality, there was a total of 23 deaths, which were all also in-hospital. There were no matched pairs where both the black and white patient died. There were 12 pairs in which only the black patient died, compared with 11 pairs in which only the white patient died ($P = .83$).

LOS was also similar; both groups had a median stay of 2.0 days, with a slightly lower percentage of black patients exceeding their own state's median LOS (30.2% of blacks versus 31.8% of whites, $P = .01$) and a similar percentage exceeding their own state's 90th percentile (7.4% of blacks versus 7.7% of whites, $P = .41$). The median difference in LOS within black and white matched pairs was 0 days with black LOS exceeding matched white LOS 34.4% of the time, whereas white LOS exceeded black LOS 35.6% of the time ($P = .13$). The mean LOS pair difference was 0 days (95% confidence interval [CI], –0.08 to 0.08; $P = .98$).

However, ICU use was higher in black patients compared with white patients (22.2% versus 17.5%, $P < .001$), and the mean paired difference in ICU days (black–white) was 0.09 days (95% CI, 0.05–0.13; $P < .001$). Black ICU days exceeded white ICU days in 19.1% of pairs, whereas white ICU days exceeded black ICU days in 14.2% of pairs ($P < .001$).

Question 2: Is the Difference Between Black and White patients the Same Across States?

The difference between black and white patients was different across states for LOS ($P = .002$), days in the ICU ($P < .001$), and ICU use ($P < .001$), but not for 30-day revisit rates. That is, the Kruskal–Wallis test looked at the matched pair differences in LOS and days in the ICU and the χ^2 test (for binary variables) looked at matched pair differences in ICU use, and concluded that the variation among states in these differences was too large to be attributed to chance.

Question 3: Do any Individual States Stand Out With Especially Large Differences Between Black and White Patients?

Our significant finding in question 2 prompted us to attempt to identify states with especially large differences between black and white patients. We only examined the 28 states where we had adequate sample sizes to conduct fine balance exclusively within the same state. Because we tested many times (3 times in each of 28 states, ie, 28 × 3 tests), we needed to correct for testing many hypotheses. We used the Bonferroni–Holm correction to control the familywise error rate for the 3 tests of interest: 30-day revisit rates, 50th percentile LOS, and ICU use. There were only 4 states that displayed a significant black–white difference after adjusting for multiple testing (Supplemental Information, Section VI listing all states). Georgia, North Carolina, Tennessee, and Texas displayed significance after multiple testing in their differences in ICU use between black and white patients. In all of these states, the ICU was used more often for black patients.

DISCUSSION

From a policy perspective, our results are reassuring. We generally did not see important differences in outcomes or practice style. Because our study was large, including >11 000 pairs of patients, we did see some statistically significant differences between black and white Medicaid patients in ICU use and LOS, but in most cases, such differences were small in any economic or clinical sense. Deaths were exceedingly rare; there were 23 deaths out of 22 158 patients, and 12 of these 23 deaths were among black patients, a difference that was not statistically or clinically significance. After adjusting for multiple testing, there were only 4 states that displayed significant black–white differences in ICU use, with higher use for black patients.

TABLE 2 The Quality of the Match

	Black Patients $N = 11\,079$	White Patients $N = 11\,079$	Standardized Difference	*P*
Girl, *N* (%)	4454 (40.2)	4457 (40.2)	0.00	.98
Mean age at admission, y (integer)	7.54	7.52	0.00	.59
Age group, *N* (%)				
3–4 y	3407 (30.8)	3423 (30.9)	0.00	.83
5–11 y	5656 (51.1)	5643 (50.9)	0.00	.87
12–18 y	2016 (18.2)	2013 (18.2)	0.00	.97
Mean predicted LOS, d	2.39	2.39	0.01	.91
Mean predicted probability of revisit	0.13	0.12	0.01	.59
Mean predicted probability of ICU use	0.17	0.17	0.01	.99
Mean asthma severity (integer 0–5)	0.84	0.84	0.00	.90
Asthma severity group				
Step 1	7994 (72.2)	7982 (72.1)	0.00	.87
Step 2	1355 (12.2)	1370 (12.4)	0.00	.77
Step 3	33 (0.3)	32 (0.3)	0.00	.99
Step 4	19 (0.2)	20 (0.2)	0.00	.99
Step 5	527 (4.8)	530 (4.8)	0.00	.95
Step 6	1151 (10.4)	1145 (10.3)	0.00	.91
Comorbidities, *N* (%)				
Diabetes	142 (1.3)	150 (1.4)	−0.01	.68
Metabolic disorders	196 (1.8)	218 (2.0)	−0.01	.30
Other blood disorders	519 (4.7)	528 (4.8)	0.00	.80
Cerebral palsy	182 (1.6)	195 (1.8)	−0.01	.53
Neural degeneration and disease	57 (0.5)	56 (0.5)	0.00	1.0
Muscular dystrophy	25 (0.2)	23 (0.2)	0.00	.89
Epilepsy and seizures	461 (4.2)	465 (4.2)	0.00	.92
Other respiratory	97 (0.9)	92 (0.8)	0.00	.77
Congenital and other heart disease	244 (2.2)	245 (2.2)	0.00	1.0
Enteritis and other digestive	26 (0.2)	39 (0.4)	−0.02	.14
Chromosomal anomalies	57 (0.5)	61 (0.6)	0.00	.78
Cancer	169 (1.5)	177 (1.6)	−0.01	.70
Immunocompromised or HIV	77 (0.7)	83 (0.8)	−0.01	.69
Autoimmune disease	31 (0.3)	33 (0.3)	0.00	.90
Major organ disorder	111 (1.0)	114 (1.0)	0.00	.89
Mental retardation	1129 (10.2)	1148 (10.4)	−0.01	.69
Congenital anomaly	404 (3.7)	426 (3.9)	−0.01	.46
Allergy: general	223 (2.0)	237 (2.1)	−0.01	.54
Allergy: peanut	144 (1.3)	151 (1.4)	0.00	.73
Allergy: food	201 (1.8)	196 (1.8)	0.00	.84
Allergy: seafood	47 (0.4)	39 (0.4)	0.01	.45
Obesity	724 (6.5)	719 (6.5)	0.00	.91
Allergic bronchopulmonary aspergillosis	NR	12 (0.1)	−0.01	.66
Gastroesophageal reflux disorder	768 (6.9)	785 (7.1)	−0.01	.67
Obstructive sleep apnea	335 (3.0)	328 (3.0)	0.00	.81
Rhinitis: chronic	670 (6.1)	674 (6.1)	0.00	.93
Rhinitis: allergic	4473 (40.4)	4469 (40.3)	0.00	.97
Sinusitis: chronic	1052 (9.5)	1086 (9.8)	−0.01	.45
Sinusitis: acute	1862 (16.8)	1897 (17.1)	−0.01	.54
Acute upper respiratory infection	6239 (56.3)	6248 (56.4)	0.00	.91
Acute otitis media	609 (5.5)	628 (5.7)	−0.01	.60
Acute pneumonia: bacterial	603 (5.4)	622 (5.6)	−0.01	.60
Acute pneumonia: viral	384 (3.5)	402 (3.6)	−0.01	.54
Acute pneumonia: organism unspecified	4290 (38.7)	4296 (38.8)	0.00	.95
Acute viral infection	2727 (24.6)	2741 (24.7)	0.00	.84
Acute dehydration	1029 (9.3)	1052 (9.5)	−0.01	.61
Previous asthma encounters (past 6 mo)				
Mean No. of emergency department visits	0.41	0.40	0.01	.38
Mean No. of asthma outpatient encounters	1.32	1.34	−0.01	.56
Mean No. of asthma admissions	1.36	1.34	0.01	.69
Any asthma emergency department visits N (%)	2298 (20.7)	2262 (20.4)	0.01	.56

TABLE 2 Continued

	Black Patients $N = 11\,079$	White Patients $N = 11\,079$	Standardized Difference	*P*
Any asthma outpatient encounters, *N* (%)	4136 (37.3)	4167 (37.6)	−0.01	.68
Any asthma admissions, *N* (%)	4362 (39.4)	4391 (39.6)	−0.01	.70

No differences in matching variables were statistically significant after the match. Standardized difference is the difference in means in units of SDs. *P* values were calculated using 2-sample balance tests: Fisher's exact test for categorical variables and Wilcoxon rank sum test for continuous variables. NR, Not reportable per CMS's current cell size suppression policy.

TABLE 3 Overall Comparison of Outcomes Across Matched Black and White Patients

	Black Patients ($N = 11\,079$)	White Patients ($N = 11\,079$)	*P*[a]
Revisit			
Revisit within 10 d, *N* (%)	418 (3.8)	462 (4.2)	.12
Revisit within 30 d, *N* (%)	1159 (10.5)	1200 (10.8)	.58
Readmission			
Readmission within 10 d, *N* (%)	100 (0.9)	106 (1.0)	.68
Readmission within 30 d, *N* (%)	283 (2.6)	274 (2.5)	.49
ICU use			
Use, *N* (%)	2458 (22.2)	1934 (17.5)	<.001
Mortality			
In-hospital mortality, *N* (%)	12 (0.11)	11 (0.10)	.99
30-d mortality, *N* (%)	12 (0.11)	11 (0.10)	.83
LOS			
Median, d (95% CI)	2.0 (2.0, 2.0)	2.0 (2.0, 2.0)	
Exceeded overall median, *N* (%)	3190 (28.8)	3329 (30.0)	.04
Exceeded own state median, *N* (%)	3351 (30.2)	3519 (31.8)	.01
90th percentile, d (95% CI)	4.0 (4.0, 4.0)	4.0 (4.0, 4.0)	
Exceeded overall 90th percentile, *N* (%)	799 (7.2)	803 (7.2)	.92
Exceeded own state 90th percentile, *N* (%)	820 (7.4)	852 (7.7)	.41
Paired difference			
Median, d (95% CI)	0.00 (0.00–0.00)		.13
Mean, d (95% CI)	0.00 (−0.08 to 0.08)		.98
Hodges–Lehmann, d (95% CI)	0.00 (0.00–0.00)		.0511
Days in ICU			
Median, d (95% CI)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	
Exceeded overall median, *N* (%)	2458 (22.2)	1934 (17.5)	<.001
Exceeded own state median, *N* (%)	2458 (22.2)	1934 (17.5)	<.001
90th percentile, d (95% CI)	1.0 (1.0, 2.0)	1.0 (1.0, 1.0)	
Exceeded overall 90th percentile, *N* (%)	1080 (9.7)	819 (7.4)	<.001
Exceeded own state 90th percentile, *N* (%)	812 (7.3)	642 (5.8)	<.001
Paired difference			
Median, d (95% CI)	0.00 (0.00–0.00)		<.001
Mean, d (95% CI)	0.09 (0.05–0.13)		<.001
Hodges–Lehmann, d (95% CI)	0.00 (0.00–0.50)		<.001

For binary variables, we tested the difference between black and white patients using the McNemar statistic. For continuous variables, the analysis used paired quantile tests using the state's own median or 90th percentage point, and a separate analysis used the pooled median and 90th percentiles. For 10-day and 30-day analyses, we used the paired Cox model, allowing for censoring. Each displayed *N* (%) does not account for censoring. For paired differences, analyses were conducted using the median (and sign test), the mean (and paired *t* test), and the Hodge–Lehmann estimate (and Wilcoxon signed-rank test). Please note, a patient "exceeds" a threshold if they have a value greater than the threshold. Values equal to the threshold are not defined as exceeding the threshold. With LOS, for example, many patients have an LOS that exactly equals the median.

[a] *P* values were calculated using tests for matched pairs.

Our results add to the literature on differences in care between black and white Medicaid pediatric asthma admissions. Lintzenich and Basco[37] described lower asthma controller medication use before admission and worse follow-up after admission in minority populations. Our study results are not inconsistent with these findings, because our analysis was aimed at examining differences in practice style and outcomes between similar black and white patients up to 30 days after discharge. This was because we were interested in whether racial disparities existed in the way hospitalized Medicaid patients were treated across states. Other studies have reported racial disparities in various populations after controlling for socioeconomic and payor status.[38–41]

Where our findings differ from previous work is in our ability to form and compare large numbers of matched pairs, rather than using standard regression for risk adjustment. In so doing, we found little evidence of differences in hospital care, matching on the

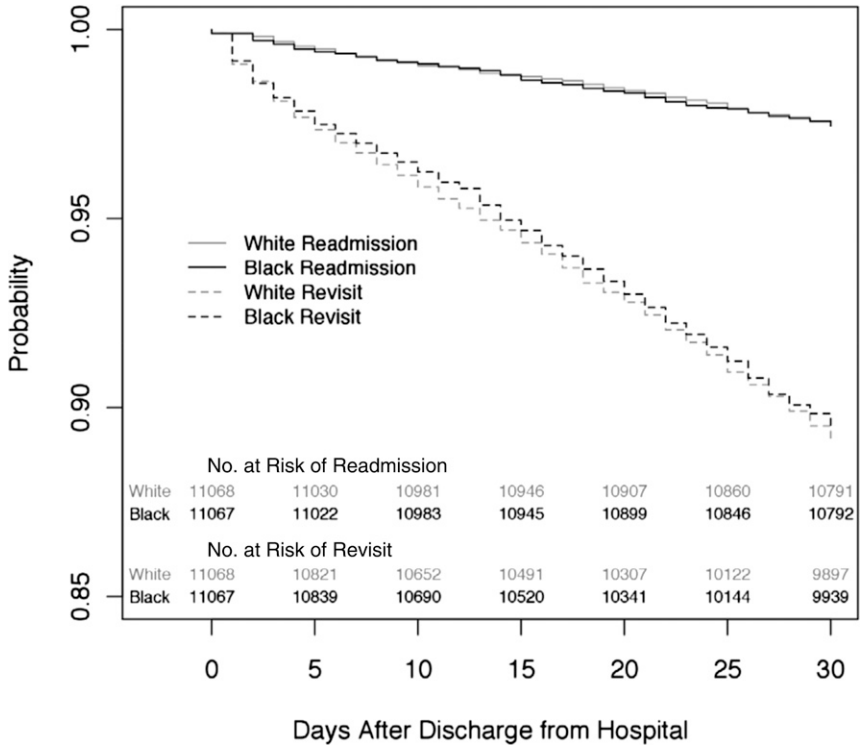

FIGURE 1

Time to revisit and readmission within 30 days postdischarge by race. Kaplan–Meier plots of revisit (dotted) and readmission (solid) rates up to 30 days postdischarge for black and white matched patients. There was no significant difference in revisit rates ($P = .58$) or readmission rates ($P = .49$) by race.

characteristics of patients on admission. We have not asked whether black and white Medicaid patients have different experiences with their asthma. There is an extensive literature suggesting that they do.[40,42–45] However, these previous studies do not address our question: are black and white patients with similar characteristics on admission to the hospital treated similarly in the hospital and do they achieve similar outcomes. The use of multivariate matching in this study allowed us to say with confidence that, after matching, patients were similar on presentation. With these similarities in presentation, it would have been concerning if we had observed important differences in style of practice and outcomes across black and white patients; we did not.

Although the style differences we observed were small for both LOS and ICU days, a reasonable question arises concerning the cause of these differences. Were these differences in some way related to inadequate admission severity adjustment (ie, were black children sicker)? It should be remembered that our study matched white to black Medicaid patients inside the same state, not within the same hospital. This matching approach was essential because we were interested in detecting outcome differences by race. If black children went to worse hospitals than whites, we may not have seen these outcome differences if whites were matched to blacks always within the same hospital. Therefore, the style differences we report may be due in part to different types of hospitals serving black and white patients.

There were important limitations to our study. This was a study using retrospective Medicaid claims from billing records. ICD-9 codes may lack accuracy and this misspecification may lead to false positive or false negative identification of patient covariates. We omitted states in this study that had <50 potential pairs for our analysis. Reasons for low numbers in some states may represent poor Medicaid data for patients in managed care and may possibly be associated with racial disparities in those states not studied. We did not have a smoking history variable for either the parent or the child, and it is well known that household smoking may be a risk factor for readmission.[13,46–48] In addition, we could not reliably track controller medication compliance, which may have helped explain readmissions,[13,46–48] although we did not see differences by race. Finally, future work is needed to explore in more detail why 4 states differed in their use of the ICU by patient race.

CONCLUSIONS

For closely matched Medicaid patients within the same state having similar characteristics on admission, race did not influence revisits, readmissions, or deaths and blacks were found to have only a small, but significant, difference in ICU use and in some measures of LOS. Because the number of children in Medicaid continues to increase due to the Affordable Care Act, it will be important to keep monitoring for potential racial disparities in hospitalization treatment styles and patient outcomes.

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ABBREVIATIONS

CI: confidence interval
CMS: Center for Medicare & Medicaid Services
ICD-9: *International Classification of Diseases, Ninth Revision*
LOS: length of stay
MAX: Medicaid Analytic eXtract
SDs: Standard Difference Score

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