Enhancing Quality Measurement With Clinical Information: A Use Case of Body Mass Index Change Among Children Taking Second Generation Antipsychotics

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Abstract

Objective: We sought to examine the extent to which body mass index (BMI) was available in electronic health records for Florida Medicaid recipients aged 5 to 18 years taking Second-Generation Antipsychotics (SGAP). We also sought to illustrate how clinical data can be used to identify children most at-risk for SGAP-induced weight gain, which cannot be done using process-focused measures.

Methods: Electronic health record (EHR) data and Medicaid claims were linked from 2013 to 2019. We quantified sociodemographic differences between children with and without pre- and post-BMI values. We developed a linear regression model of post-BMI to examine pre-post changes in BMI among 4 groups: 1) BH/SGAP+ children had behavioral health conditions and were taking SGAP; 2) BH/SGAP- children had behavioral health conditions without taking SGAP; 3) children with asthma; and 4) healthy children.

Results: Of 363,360 EHR-Medicaid linked children, 18,726 were BH/SGAP+. Roughly 4% of linked children and 8% of BH/SGAP+ children had both pre and post values of BMI required to assess quality of SGAP monitoring. The percentage varied with gender and race-ethnicity. The R^2 for the regression model with all predictors was 0.865. Pre-post change in BMI differed significantly ($P < .0001$) among the groups, with more BMI gain among those taking SGAP, particularly those with higher baseline BMI.

Conclusion: Meeting the 2030 Centers for Medicare and Medicaid Services goal of digital monitoring of quality of care will require continuing expansion of clinical encounter data capture to provide the data needed for digital quality monitoring. Using linked EHR and claims data allows identifying children at higher risk for SGAP-induced weight gain.

Keywords: digital quality measures; metabolic monitoring; quality measurement; race-ethnicity; rurality

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What's New

Incorporating clinical information into quality measurement holds promise for measuring both processes and outcomes of care. Missing clinical information disproportionately affects different subgroups of children, potentially contributing to inequities in assessing the quality of care.

As many as 10% of children in Medicaid overall and 22% in foster care take antipsychotic medication.[1,2] Antipsychotic use among children peaked around 2005 and has declined since then due to state Medicaid Program measures.[3] Despite the decline in use, children continue to be placed on the medications and require monitoring to ensure high-quality care. The Pediatric Quality Measures Program[4] and the National Collaborative for Innovation in Quality Measurement led the development of the "Safe and Judicious Use of Antipsychotics in Children" measure set.[5,6] Metabolic monitoring is a component of that measure set and includes whether children received glucose and lipid testing annually. However, the measure does not incorporate clinical information thereby limiting the ability to improve children's health outcomes, as opposed to processes alone.

Body mass index (BMI) is a particularly important clinical outcome because weight gain is one of the most common side effects of second-generation antipsychotics (SGAPs), with up to 80% of children gaining weight,

depending on the medication used.[7] SGAP-induced weight gain is observed more in children than in adults and may further contribute to long-term psychological distress and social withdrawal throughout early adulthood.[8] Clinical information can inform quality improvement in 3 ways: 1) identification of children at greatest risk of weight change for enhanced monitoring and early intervention, 2) implementation of lifestyle interventions tailored to children's unique needs,[9–11] and 3) development of provider capacity to intervene with children experiencing weight gain.

The Centers for Medicare and Medicaid Services (CMS) is transitioning to digital quality measures (dQMs) that use data from electronic health records (EHRs), registries, and other sources to reduce reporting burden while also providing access to clinical information that can support evaluation and care improvement.[12] dQMs provide more refined information to assess quality of care and to implement evidence-based interventions including enhanced screening.[13] Further, dQMs have the potential to facilitate rapid-cycle feedback and learning because the data are captured more readily from EHRs in contrast to traditional quality measures that rely on health care claims and/or medical record abstraction. dQMs also have the potential to inform a learning measurement system, where the measures themselves are rapidly refined based on user experience and lessons learned.[13]

While CMS's goal is to have all quality measures digital by 2030, several key considerations must be addressed to spur dQM development and use. The availability and accuracy of clinical data from EHRs are central to the transition to dQMs, yet are potentially a hurdle to the advancement of a digital quality ecosystem. In this study, we examined the extent to which clinical information about BMI or height and weight to calculate BMI, were available in EHRs for children taking SGAPs. A single record of BMI or height and weight is not enough. Assessing weight gain requires 2 or more measurements spaced sufficiently apart in time. Moreover, the requirement of 2 or more measures at different time points is consistent with CMS guidelines for Medicaid Program performance improvement projects.[14] Therefore, we compared the sociodemographic characteristics of children with 2 or more BMI values to those with one or no measures to identify potential biases in the data. Further, within the subset of children with two BMI measures, we examined how the clinical data can be used to identify children most at-risk for weight gain, which cannot be done using process-focused measures.

METHODS

DATA SOURCES

We used Florida Medicaid Program claims linked to the children's EHR data contained in the OneFlorida Data Trust. The OneFlorida Data Trust is a centralized data repository containing EHR data for 17 million Floridians from 10 health care systems from 2012 to the present and refreshed quarterly.[15] Together the health systems form the OneFlorida Clinical Research Consortium, one of nine Patient-Centered Outcomes Research Institute-funded sites nationally. A data use agreement between the University of Florida and Florida Medicaid allows for the data linkage. The linked data are Health Insurance Portability and Accountability Act-limited data sets, which restrict protected health information to dates (eg, birthdates) and location (5 or 9-digit zip code level, which allows for geocoding). The health system partners submit the data to the Data Trust and it is harmonized using the Patient-Centered Outcomes Research Institute's Common Data Model.[16] The data undergo a quality characterization every six months through the PCORnet Coordinating Center and must meet pre-defined standards to be approved for study use.

Variables were obtained from children's EHRs and Medicaid claims and enrollment data. Claims data were used to identify medication use (name, type, fill date, number of supply days), diagnosis (codes and dates), 5- or 9-digit zip codes, and enrollment (enrollment status and month). The children's health status was computed from claims data using the 3M Clinical Risk Groups.[17] Enrollment files were used to identify the children's race and ethnicity and age and to calculate their social vulnerability index and Rural-Urban Continuum Codes using 5- or 9-digit zip codes. BMI and obese status were computed using the height, weight and measure date from EHRs.

STUDY DESIGN AND INCLUSION CRITERIA

This is a cohort study in Medicaid-insured children and adolescents with behavioral health conditions using claims and EHR data from 2013 through 2019. Children 5 to 18 years old who met the following eligibility criteria were included to 1) examine the extent to which BMI or height and weight were available in EHR data and 2) quantify the characteristics of children most at risk for weight gain to illustrate how the information could be used for quality improvement planning.

We included 4 study groups: an exposure group, a control group and two comparison groups. The exposure group contained children diagnosed with at least one behavioral health condition and subsequently taking SGAP (BH/SGAP+ group). The control group contained children who had at least one behavioral health condition without any SGAP (BH/SGAP- group). Because the use of SGAP was not assigned randomly, we included two additional comparison groups to account for the expected increase in weight as children grow: 1) children who had no behavioral health conditions but were diagnosed with asthma, a common chronic physical condition (Asthma group) and 2) children determined as healthy according to 3M Clinical Risk Groups (Healthy group).[17]

For each group, we identified the numbers of children with BMI and/or height and weight information. We also compared the sociodemographic characteristics between children with and without both pre- and post-BMIs to quantify potential biases that may be present when examining the clinical outcome.

To quantify the characteristics of children most at risk for weight gain, we examined the presence and duration of SGAP use using medication fill date and supply days from Medicaid claims dispensing data. Children were SGAP+ if they had at least one month of drug use. SGAP prescriptions were identified using National Drug Codes.[18] Behavioral health conditions and asthma were identified using the International Statistical Classification of Diseases 9th and 10th Revision. The child needed to have one inpatient or two outpatient encounters using E & M physician visit code visits with the behavioral health or asthma diagnosis. We used the earliest observed behavioral condition diagnosis as the index diagnosis if a child had multiple behavioral conditions.

Because the BMI data were from EHRs without a prespecified schedule for data collection, we selected an index date as the baseline for each child. The index date was defined as the first date observed for SGAP dispensing for the BH/SGAP+ group, the behavioral health condition diagnosis for the BH/SGAP-group, the asthma diagnosis for the Asthma group, or January 1 of the year with 3M Clinical Risk Group status determined as healthy for the Healthy group. BMI at baseline is defined as the BMI measurement 0 to 6 months before the index date. The children also had to have a post-BMI measured 12 $\pm$ 3 months after the index date. One single year of the outcome data for each participant was included in the analysis. To simplify the study, we did not include multiple years of post-BMIs in the analysis since the number of available BMI measurements and the time intervals between BMI or height and weight measurements varied among children.

Although we do not have medication information prior to Medicaid enrollment, more than 75% of the children in the BH/SGAP+ group had at least 12 months between the enrollment date and the date of their first SGAP use, which can be considered a washout period to establish incident users.

Outcomes

There are two outcomes of interest: 1) variations in the sociodemographic characteristics of children with and without two recorded BMIs, and 2) expected change in BMI 12 $\pm$ 3 months after initiating SGAP associated with sociodemographic characteristics and baseline health.

For children and adolescents, BMI is influenced by normal growth and development and body fat accumulation. Change in BMI is also age- and sex-dependent. We chose BMI rather than age- and sex-adjusted BMI z-score because 1) we were interested in the subgroup difference between males and females in weight gain and 2) BMI z-scores have limitations in tracking individuals with severe obesity.[19,20] We used the Centers for Disease Control method to detect and remove biologically implausible values for data cleaning.[21] We assessed the data quality using a univariate correlation between BMI at baseline and post-BMI after data cleaning.

Participant Characteristics

Participant characteristics used as predictor variables included age, sex, race-ethnicity, rurality of residence, social vulnerability index, baseline BMI, and study groups. Race-ethnicity was grouped as Hispanic, non-Hispanic (NH)-White, NH-Black, NH-Other, and Unknown. Rurality was determined by aggregating Rural-Urban Continuum Codes with 1 as urban, 2 to 3 as metro, and 4 to 9 as rural area.[22] The social vulnerability index is a composite measure of social vulnerability at the census tract level where census tracts are ranked using 15 social factors (eg, socioeconomic status, household composition, housing, transportation).[23]

Statistical Analyses

To quantify differences in sociodemographic characteristics for children with or without both pre- and post-BMIs in the EHR, we used the nonparametric Wilcoxon 2-sample test for the continuous variable of age, and the chi-square test for the categorical variables. For the use case examining BMI changes, we fit general linear regression models with post-BMI as the outcome. Both linear and quadratic terms of age to control for the nonlinear relationship between BMI and age within the study cohort. Age was centered by the sample mean of 11.3 years. Interaction terms that caused collinearity were not included. The full model included all the primary predictors and 2-way interactions between study group and sex, race-ethnicity, baseline BMI, rurality, social vulnerability index. We also tested 2-way interactions between sex by race-ethnicity, sex by baseline BMI, and race-ethnicity by baseline BMI. Only significant interactions remained in a final model.

We conducted a residual analysis to check if model assumptions were satisfied. Regression coefficients and their standard errors, and P values of all the predictors were reported. A nominal level of P value $\leq .05$ was used for statistical significance. Changes in R^2 were also reported as the measures of association between the outcome and the predictors to assess the importance of one or more variables in predicting post-BMI. All statistical analyses were performed in SAS Version 9.4 (SAS Institute, Cary, NC).

Results

Sociodemographic characteristics between children with and without pre- and post-BMI records were compared (Table 1). A total of 363,360 children were identified from the Data Trust who were in the BH/SGAP+, BH/SGAP-, Asthma or Healthy groups. Of these children, only 4.2% had both pre- and post-BMI records in the EHR. Among BH/SGAP+ children, the percentage was 7.6%. A higher percentage of females relative to males and a lower percentage of NH-Black children had both pre- and post-BMI records ($P < .0001$). A higher percentage of two recorded BMIs was also observed among children in metro and rural areas ($P < .0001$). No significant differences were observed based on socioeconomic vulnerability.

Table 1. Sociodemographic Characteristics of Participants With or Without Both Pre- and Post-BMI Records by Study Group at Baseline*

	Study Group									
	BH/SGAP+		BH/SGAP-		Asthma		Healthy		All	
Variable	0−1 BMI (n = 17,309)	2+ BMI (n = 1417)	0-1 BMI (n = 125,979)	2+ BMI (n = 8597)	0-1 BMI (n = 21,970)	2+ BMI (n = 1763)	0-1 BMI (n = 182,860)	2+ BMI (n = 3465)	0-1 BMI (n = 348,118)	2+ BMI (n = 15,242)
Age (mean ± SD)	12.4 ± 3.5	12.3 ± 3.6	10.7 ± 3.8	11.3 ± 3.9	10.0 ± 3.6	10.2 ± 3.7	11.5 ± 3.8	11.8 ± 4.0	11.2 ± 3.8	11.3 ± 3.9
Female (%)	40.9%	46.1%	47.2%	52.8%	47.4%	51.2%	53.9%	58.2%	50.4%	53.2%
Race/ethnicity										
NH-White (%)	33.5%	30.8%	28.8%	30.1%	17.2%	14.4%	22.5%	19.6%	25.0%	25.9%
NH-Black (%)	18.8%	14.2%	25.4%	23.9%	31.2%	32.6%	30.6%	29.9%	28.2%	25.4%
Hispanic (%)	16.1%	19.6%	31.0%	29.2%	41.2%	42.6%	36.9%	39.0%	34.0%	32.1%
NH-Other (%)	4.7%	4.6%	6.9%	7.1%	8.9%	7.8%	9.1%	10.1%	8.0%	7.6%
Unknown (%)	26.9%	30.8%	7.9%	9.7%	1.5%	2.6%	1.0%	1.4%	4.8%	8.9%
Rurality										
Rural (4−9) (%)	4.7%	6.9%	4.6%	5.5%	3.0%	2.3%	3.3%	2.2%	3.8%	4.5%
Metro (2−3) (%)	30.7%	27.0%	21.1%	24.6%	17.8%	13.6%	17.4%	15.7%	19.4%	21.5%
Urban (1) (%)	55.1%	57.4%	65.9%	61.9%	71.4%	78.0%	71.5%	74.6%	68.7%	66.2%
Undetermined (%)	9.5%	8.7%	8.4%	7.9%	7.9%	6.1%	7.9%	7.5%	8.1%	7.7%
Social vulnerability index										
1st quartile (%) (least vulnerable)	9.8%	9.6%	9.0%	9.3%	6.9%	7.5%	8.9%	9.2%	8.9%	9.1%
2nd quartile (%)	18.1%	19.1%	17.7%	18.7%	16.2%	15.4%	17.7%	17.7%	17.6%	18.1%
3rd quartile (%)	25.1%	24.8%	25.2%	26.2%	25.5%	26.0%	25.9%	26.4%	25.6%	26.1%
4th quartile (%) (most vulnerable)	37.5%	37.8%	39.8%	38.0%	43.4%	44.9%	39.7%	39.2%	39.8%	39.0%
Undetermined (%)	9.5%	8.7%	8.4%	7.9%	7.9%	6.1%	7.9%	7.5%	8.1%	7.7%

BH indicates behavioral health; SGAP, second-generation antipsychotics; NH, non-Hispanic; and BMI, body mass index.

*Participant characteristics were compared between children with both pre- and post-BMIs (2+ BMI) and children without both BMI measures (0−1 BMI) within each study group and in the whole study population. Continuous variable age was compared using a non-parametric Wilcoxon two-sample test, and categorical variables were compared using the chi-square test. All comparisons are statistically significant (P value < .0001), except for the social vulnerability index in BH/SGAP+ group (P value = .18).

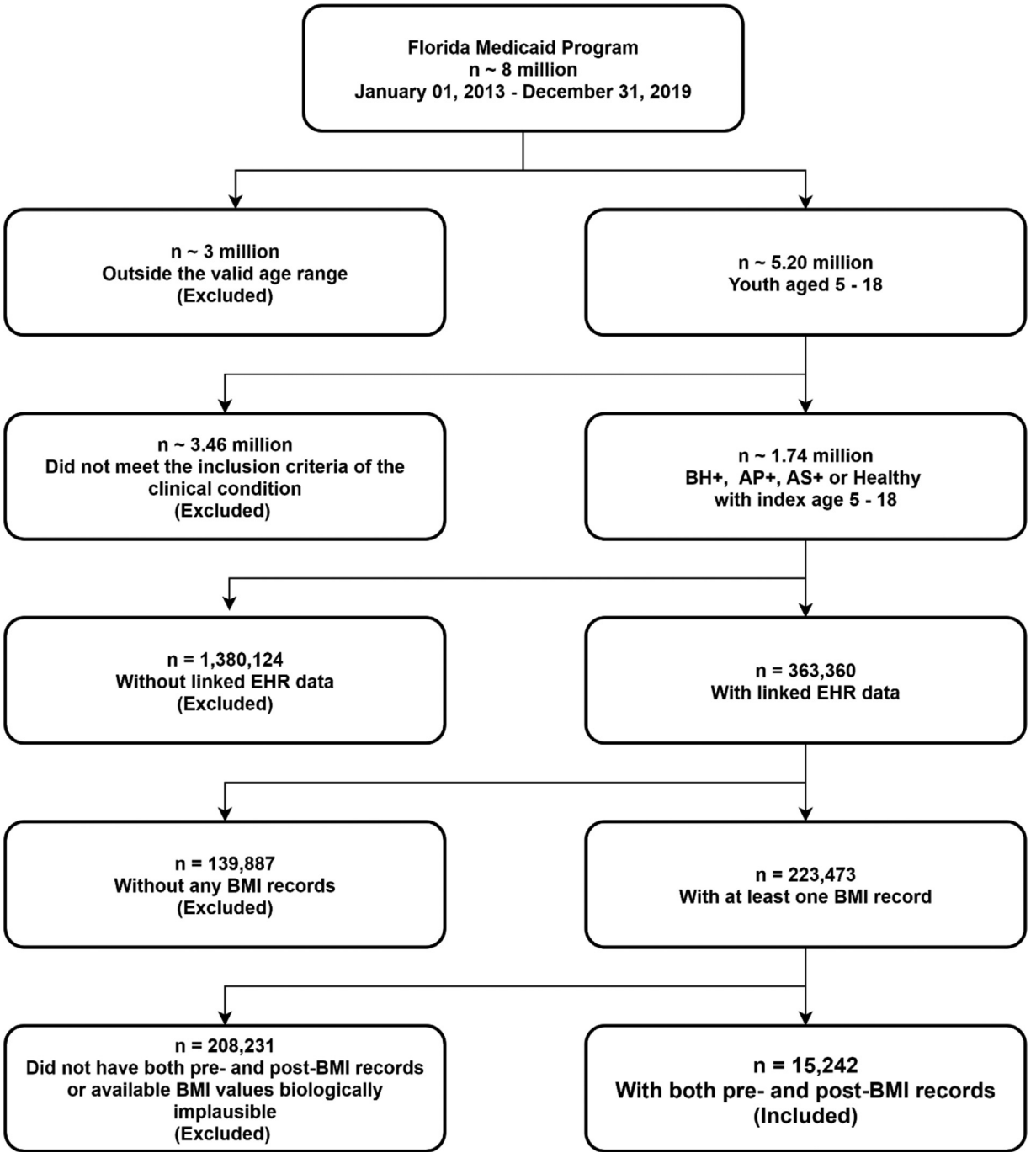

Figure 1. *Flow chart of the participants included in the analysis from linked OneFlorida Data Trust and Florida Medicaid Claims Data between January 1, 2013 and December 31, 2019.*

To examine changes in BMI, 15,242 children with both pre- and post-BMI records were included in a regression analysis. Figure 1 illustrates the sample selection process and the reason for elimination at each step. Sociodemographic characteristics for the regression analysis are presented in Table 1. The BH/SGAP+ group was 46.1% female, compared to 52.8% females in the BH/SGAP- group, 51.2% in the Asthma group, and 58.2% in the Healthy group. There were 14.2% NH-Blacks and 19.6% Hispanics in the BH/SGAP+ group, compared to 23.9% NH-Blacks and 29.2% Hispanics in the BH/SGAP- group. Further, 30.8% of children had an unknown race in BH/SGAP+ group, higher than those in BH/SGAP- group (9.7%), Asthma group (2.6%), and Healthy group (1.4%).

Higher percentages of children with behavioral health conditions (6.9% in the BH/SGAP+ group and 5.5% in the BH/SGAP- group) live in rural areas than those without behavioral health conditions (2.3% in the Asthma group and 2.2% in Healthy group). There were lower percentages of children with behavioral health conditions living in urban areas with 57.4% of children in the BH/SGAP+ group and 61.9% in the BH/SGAP- group, in contrast to 78.0% in the Asthma group and 74.6% in the Healthy group. The distributions of social vulnerability

Table 2. Clinical Characteristics in Children With 2 or More BMIs by Study Group at Baseline

	Study Group				
Clinical Variable	BH/SGAP+ (n = 1417)	BH/SGAP- (n = 8597)	Asthma (n = 1763)	Healthy (n = 3465)	Total (n = 15,242)
BMI at baseline	21.6 ± 6.1	21.2 ± 6.1	20.5 ± 5.7	21.1 ± 5.7	21.1 ± 6.0
Obesity (%)	23.0	24.7	25.4	20.3	23.6
BH condition (%)*					
Schizophrenia	1.4	0.4	.	.	0.4
Autism w/o irritability	6.8	2.1	.	.	1.8
Autism with irritability	2.8	0.0	.	.	0.3
Bipolar	3.5	1.2	.	.	1.0
ADHD w/o conduct disorder	19.4	24.8	.	.	15.8
ADHD with conduct or disruptive disorder	12.8	2.1	.	.	2.4
Conduct or disruptive disorder, no ADHD	1.2	2.0	.	.	1.2
Anxiety or depression	16.4	23.6	.	.	14.8
Trauma and stressor / adjustment related	7.7	13.0	.	.	8.0
Other mental health disorder	28.0	30.9	.	.	20.0
No BH condition	.	.	100.0	100.0	34.3
Type of antipsychotics					
Risperidone	49.26	.	.	.	.
Olanzapine	5.01	.	.	.	.
Quetiapine	16.37	.	.	.	.
Aripiprazole	23.08	.	.	.	.
Asenapine	0.00	.	.	.	.
Clozapine	0.07				
Lurasidone	1.98	.	.	.	.
Ziprasidone	4.52	.	.	.	.
Iloperidon	0.00	.	.	.	.
Paliperidone	0.35	.	.	.	.

BH indicates behavioral health; SGAP, second-generation antipsychotics; BMI, body mass index; and ADHD, attention deficit hyperactivity disorder.

index quartiles were similar across the four groups. The baseline BMI was slightly higher in BH/SGAP+ (21.6 ± 6.1) compared to the other three groups (21.2 ± 6.1 in BH/SGAP-, 20.5 ± 5.7 in Asthma, and 21.1 ± 5.7 in the Healthy group).

Table 2 presents the clinical characteristics of the children. A higher percentage of BH/SGAP+ children had obesity (23.0%) compared to healthy children (20.3%). Behavioral health conditions differed between children taking or not taking SGAP medications. Higher percentages of children with conditions for which SGAP had first-line indications (schizophrenia, autism and bipolar disorder) were in the BH/SGAP+ groups than in the BH/SGAP- groups. Behavioral health conditions associated with the highest SGAP use were ADHD with (12.8%) and without SGAP use were conduct disorder (19.4%), anxiety or depression (16.4%), and other mental health disorders (28%). Risperidone was the most frequently used SGAP (49.3%), followed by aripiprazole (23.1%), and quetiapine (16.4%).

The univariate correlation coefficient was 0.928 between BMI at baseline and post-BMI measured 12 ± 3 months after the index date. In turn, R^2 equals $0.928^2 = 0.861$, which indicates 86% post-BMI variability is predictable by baseline BMI.

The final regression model predictors were age, age^2, sex, race-ethnicity, sex × race-ethnicity, rurality, social vulnerability index, baseline BMI, baseline BMI × sex, baseline BMI × race-ethnicity, study group, study group × sex, and study group × baseline BMI (Table 3). Overall, the model fit was excellent with an R^2 of 0.8654.

In the final model, the results for primary predictors were all statistically significant. The post-BMI measure was strongly associated with social vulnerability index ($\Delta R^2 = 0.0018$), rurality ($\Delta R^2 = 0.0002 + 0.0016 = 0.0018$), race-ethnicity ($\Delta R^2 = 0.0019$), sex ($\Delta R^2 = 0.0041$), baseline BMI ($\Delta R^2 = 0.5842$), and age ($\Delta R^2 = 0.2674$ including both the linear and the quadratic terms of age). Approximately 27% of the variation in post-BMI is explained by age and 58% is explained by baseline BMI (adjusted for age, sex, race-ethnicity, interaction between sex and race-ethnicity, rurality, and social vulnerability index). There were small but statistically significant associations between post-BMI and race-ethnicity, rurality and social vulnerability index. The large sample size in this study allowed detecting small clinical effects, with all *P* values less than .0001 for the main effects of the predictors.

Interactions were examined in detail. Females had a higher predicted post-BMI than males in all study groups except Asthma. The predicted post-BMI was 22.7 in males in BH/SGAP+, and 21.7 in males in BH/SGAP-, showing a 1.02 greater increase in BMI in BH/SGAP+ compared to BH/SGAP- in males. The significant interaction of baseline BMI with the study group indicates that the slope of the regression line predicting post-BMI from baseline BMI differs by study group. The slope is 1.008 ± 0.011 in BH/SGAP+ group, which is higher than the slopes in the control and the comparison groups (Fig. 2). As expected, children taking SGAP had an increase in

Table 3. Regression Model Predicting BMI 12 ± 3 Months After Baseline

Variable	Regression Coefficient	Standard Error	*P* Value	ΔR^2
Intercept	21.79	0.10	<.0001	
Age in year*	0.05	0.01	<.0001	0.2647
Age^2	-0.01	0.00	<.0001	0.0027
Sex (ref = female)	-0.07	0.11	<.0001	0.0041
Race-ethnicity (ref = White)			<.0001	0.0019
Black	0.13	0.08		
Hispanic	0.15	0.07		
Other	0.12	0.11		
Unknown	0.38	0.11		
Sex × race-ethnicity			<.0001	0.0015
Male × Black	-0.19	0.11		
Male × Hispanic	0.01	0.10		
Male × other	-0.08	0.16		
Male × unknown	-0.33	0.15		
Rurality (ref = urban)				
Metro	0.06	0.05	<.0001	0.0002
Rural	-0.01	0.09	<.0001	0.0016
Social vulnerability index (ref = 1st quartile)			<.0001	0.0018
2nd quartile	0.09	0.08		
3rd quartile	0.11	0.07		
4th quartile (most vulnerable)	0.18	0.07		
Undetermined	0.18	0.09		
Baseline BMI	0.96	0.01	<.0001	0.5842
Baseline BMI × Male	-0.02	0.01	.0017	0.0001
Baseline BMI × Race-ethnicity			.0245	0.0001
Baseline BMI × Black	0.01	0.01		
Baseline BMI × Hispanic	-0.01	0.01		
Baseline BMI × other	-0.01	0.01		
Baseline BMI × unknown	0.02	0.01		
Group (ref = healthy)†			<.0001	0.0021
BH/SGAP+	1.05	0.11		
BH/SGAP-	0.02	0.06		
Asthma	-0.10	0.09		
Sex × group			.0013	0.0001
Male × BH+/SGAP+	-0.13	0.16		
Male × BH/SGAP-	-0.12	0.10		
Male × asthma	0.33	0.14		
Baseline BMI × group			.0001	0.0002
Baseline BMI × BH/SGAP+	0.06	0.01		
Baseline BMI × BH/SGAP-	0.01	0.01		
Baseline BMI × asthma	0.00	0.01		

BH indicates behavioral health; SGAP, second-generation antipsychotics; and BMI, body mass index.

*Age was centered by subtracting its mean 11.3 years.

†BH/SGAP+: children having behavioral conditions and taking second-generation antipsychotics; BH/SGAP-: children having behavioral conditions without second-generation antipsychotics; Asthma: children with asthma; Healthy: healthy children.

BMI gain as opposed to those not taking the medications. The increase in BMI was even higher in children who had higher BMI at baseline for all cohorts. This finding is particularly important for children taking SGAP who have a greater risk for BMI increases across time relative to children not taking SGAP.

DISCUSSION

The "Safe and Judicious Use of Antipsychotics in Children and Adolescents" measurement set includes assessing metabolic monitoring, that is, whether glucose and lipid tests were conducted. Clinical information about the children's actual laboratory results, weight and height (or BMI) is not captured. In our study, we focused on assessing repeated measures of BMI for three primary reasons. First, BMI records should be available in the EHR data for all children. Second, childhood obesity is associated with an increased risk of cardiovascular disease, type 2 diabetes, anxiety and depression.[24,25] Third, there is some evidence that overweight and obesity contribute to poorer outcomes among children with serious mental illnesses such as bipolar disorder.[26]

Digital quality measures, with their use of EHR data, have the potential to guide quality improvement efforts toward addressing outcomes of care. However, careful attention must be paid to data quality and to biases that may be present in the data. In our case, children who are male or NH-Black may not be accurately represented in

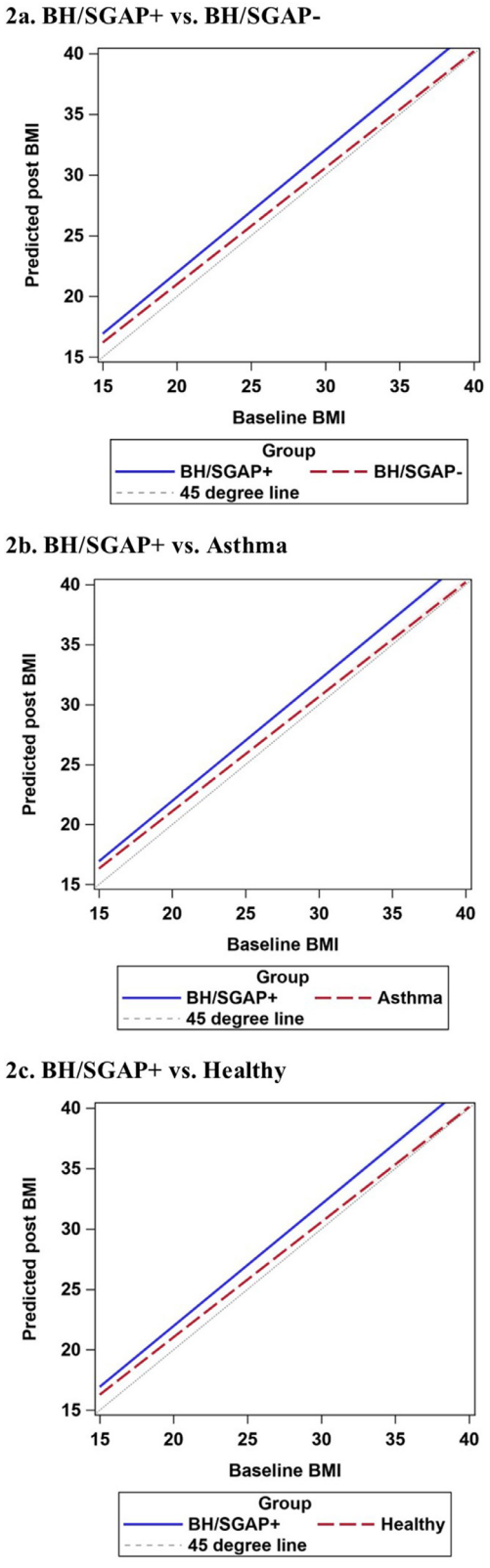

Figure 2. *Regression plots of BMI at baseline versus post-BMI by study group.*

dQMs focused on BMI. We do not know if the missing data are related to a lack of obtaining or recording BMI or height and weight. This is a finding that requires further exploration of the potential causes to improve care and data quality.

Using linked Medicaid claims and EHR data, for those children with at least two BMI records, we assessed the impact of multiple variables on weight gain in children taking SGAP. At baseline, 17.3% of children included in this study overall had a BMI indicative of overweight and 23.6% had a BMI indicative of obesity for a total of 41% of children with overweight or obesity. Children taking SGAP had a significant increase in BMI compared to children without SGAP, which is consistent with the literature.[7] Health and sociodemographic characteristics were positively associated with weight gain. For example, females and those with higher BMIs at baseline were most at-risk for greater weight gain when taking SGAPs pointing to opportunities for early intervention with these subgroups, in particular.

A key feature of this study was the use of EHR data to examine clinical outcomes for a large group of children. However, we found that among the 18,726 children taking SGAPs only 7.6% had two BMIs recorded at sufficient intervals to examine change across time. This raises the importance of addressing the measurement and documentation of BMI in the EHR as a quality of care concern.

Quality of care measurement has historically relied on process measures and health care claims data. However, attempts are being made to better measure clinical outcomes by using information from EHRs.[27] While the OneFlorida Data Trust and the partnership with Florida Medicaid is an example of linking EHR and claims data to better understand clinical outcomes, more work remains to be done to ensure key measures of children's health are captured, such as height, weight and BMI. This is especially important in light of our finding that higher percentages of children who were males and NH-Blacks, for example, were excluded from the regression analyses requiring two or more BMI records, relative to females and white children.

There are limitations to the study. First, we are relying on EHR data from ten health systems in Florida, which may not be representative of the quality of EHR data from other providers. Second, children without SGAP have different distributions of sex, race-ethnicity, and particular behavioral disorders compared to those taking SGAP. Adding comparison groups partially assesses, but may not completely control for confounding. Third, while generally considered a drug class effect, the degree of weight gain following SGAP exposure varies across individual drugs.[28] We did not examine the effects of specific SGAP medications. Finally, the results may not be generalizable to children who do not have the characteristics of those included in the study. While non-Hispanic white children comprised only 26% of the children in the study, underrepresented children were more likely to be excluded from the analyses requiring two or more BMI records due to missing data. Further, missing BMI information may not be random and there could be unmeasured reasons for the missingness such as provider, health care setting or child-level factors. Nonetheless, our findings provide valuable information about the potential use of linked

Medicaid claims and EHR data to incorporate clinical outcomes into quality measurement compared to traditional medical record review processes with small sample sizes and uncertain generalizability.

In conclusion, our results demonstrate the importance of addressing gaps in available clinical information by carefully assessing underlying causes including failure to provide and/or document the care. Moreover, our findings indicate that missing clinical information disproportionately affects different subgroups of children, potentially contributing to inequities in assessing the quality of care. Our use of the BMI information demonstrated an increase in children's BMI 1 year after SGAP initiation while controlling for normal growth. The increase in BMI was higher in children who started with a higher BMI. BMI also differed with race-ethnicity and social vulnerability index, with the differences independent of SGAP medication use. Our findings point to opportunities to better capture clinical information, such as BMI, to advance the measurement of health outcomes for children taking SGAP. This information, in turn, can inform the development of quality improvement initiatives to prevent or reduce weight gain among vulnerable children.

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