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Original article

An exploratory look at comorbidities, utilization, and quality of care among obese and nonobese children in academic family medicine practice

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A B S T R A C T

Background: Obesity is one of the least addressed comorbidities among children who attend family medicine clinics. The aim of this study was to apply a population health framework to understand the differences between obese and nonobese pediatric patients in academic family medicine practice with regard to general demographics, comorbidities, and quality measures.

Methods: Exploratory retrospective chart reviews were conducted among obese children aged 2–17 years and a random sample of age-matched nonobese children in 2015. Data were gathered through the institute's electronic medical record system and included demographics, ICD-10 diagnosis codes, outpatient primary care and specialty care visits, in-network emergency department visits, and in-network hospital admissions.

Results: This exploratory study suggested that the obese pediatric population (n = 213) had a high prevalence of hypertension ($P = .006$) and sleep apnea ($P = .05$) and a larger number of diagnosed comorbidities ($P = .008$), whereas nonobese children had a high prevalence of environmental allergies ($P = .001$). There were no significant differences among quality measures between obese (n = 213) and age-matched nonobese pediatric patients (n = 219).

Conclusion: This study used readily available electronic health record data to highlight comorbidities that are more common among obese pediatric patients in academic family medicine practice, thus providing information that could potentially facilitate more timely screening and intervention.

1. Introduction

In the United States, obesity rates for children have doubled during the past 30 years, with approximately 17% (12.7 million individuals aged 2–19 years) reported as obese (BMI ≥ 95th percentile) [1]. Moreover, evidence suggests that obesity rates vary by age of the cohort, such that during 2011–2012, the obesity rate was 8.9% for children aged 2–5 years old, 17.5% for those aged 6–11 years old, and 20.5% for individuals aged 12–19 years old [1]. The general epidemiological increase in obesity is also associated with a significant increase in medical expenditures, increasing from $78.5 billion in 1998 to $147 billion in 2008 (9% of all medical costs) [2,3]. By 2010, net costs increased to $190.2 billion, or 21% of all medical costs, with $14 billion attributed to childhood obesity alone [3–5].

Although obesity may be noted across all socioeconomic status (SES) strata, not all children appear to be equally at risk for becoming obese [6]. Children and adolescents who live in poverty-stricken areas with a high area deprivation index (ADI) and/or who are ethnic minorities have an increased risk for developing obesity and other comorbidities [7–9]. Lack of physical activity, unsafe neighborhoods, food deserts, and underfunded school districts without consistent exercise and health education programs are

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some of the many potential factors that may increase the risk for developing and maintaining obesity [6].

Despite these alarming trends, historically, obesity has remained among the least addressed comorbidities in all populations, including among children who attend family medicine clinics, despite the fact that family physicians are well positioned to intervene in pediatric obesity [6,10–12]. There has been a call to recognize this potential need at a national level to facilitate appropriate screening and intervention [13,14]. Specifically, family physicians and other health care providers are assigned with identifying risk factors, selecting prevention measures, accurately diagnosing obesity and its severity, and initiating timely treatment plans [6]. Considering that health behaviors learned at a young age have the potential to be carried throughout life, early detection and intervention may nurture the development of lifelong healthy behaviors [15]. Many studies have noted that pediatricians are increasingly underdiagnosing and failing to manage weight-related problems in obese children [16,17]. To improve quality of care in obese children, in 2009, the National Committee for Quality Assurance released the Healthcare Effectiveness Data and Information Set (HEDIS), which contains nationally standardized performance measures. In 2010, the United States Preventive Services Task Force lowered the age for recommended screening for obesity from 6 years to 2 years [18]. Despite this, most family medicine physicians—and primary care physicians in general—report that they do not consistently track children's weight or weight-related problems with time [19]. Population health measurements, including assessments of patterns of comorbidities, are an important first step. Therefore, collecting and analyzing data regarding childhood obesity in family medicine practice could encourage “next steps” in identifying ways to address the extent of the issue in a patient-centered manner [6].

This study represents one step toward fulfilling a call in the literature for family physicians to take a larger role in recognition and interventional phases of obesity management in pediatric populations [14,20–22]. To our knowledge, this is the first study employing an exploratory, electronic health record-driven, and population health-based approach to examine differences among obese and nonobese children visiting an academic family medicine practice. This study has three aims: (1) to explore the prevalent patterns in comorbidities among obese and nonobese children, (2) to evaluate patterns of in-network health care utilization among obese and nonobese children, and (3) to assess whether there are potential differences in quality of care among obese and nonobese children using measures from the Children's Health Insurance Program Reauthorization Act of 2009 (CHIPRA) 2017 Core Data Set [23].

2. Methodology

This study was approved by the Thomas Jefferson University (TJU) Institutional Review Board. The children in this study were identified according to their visit to Jefferson's primary academic family medicine practice in downtown Philadelphia, PA, within the study period. Data were obtained from the institution's electronic medical record (EMR). We first reviewed the demographics of all children aged 2–17 years (in 2015) who were patients at the institution's core academic family medicine practice (n = 1982). BMI is automatically calculated in the EMR using the patient's height and weight. BMI scores were then compared using the Centers for Disease Control and Prevention's BMI Percentile Calculator for Child and Teen [24] to determine BMI percentile categories for each patient. Of the 1982 children, 219 of them were obese (BMI of the 95th percentile and higher) in 2015. We then created a comparison group of nonobese children within the same practice using a random sample matched to the obese sample by age categories of 2–5, 6–11, and 12–17 years old (n = 219). Upon subsequent chart review, six children initially placed in the obese category during EMR data extraction were found to not be obese during the study period. Subsequently, these six children were excluded from the study, thus leaving a total of 213 obese and 219 nonobese children (obese, $n = 213$; nonobese, $n = 219$).

ICD-10 diagnosis codes, medications, outpatient primary care and specialty care visits, and in-network emergency department visits and hospital admissions were linked from the EMRs of the hospital system. Chart reviews were conducted for children identified as obese, as well as the matched nonobese children, to confirm the patient's BMI demographic information (age, race, sex, and zip code). Each patient's ADI was calculated. The ADI is a measure of socioeconomic deprivation based on 17 Census measures depending on an individual's nine-digit zip code. The ADI is designed to have a national mean of 100 and a standard deviation of 10, with a higher score indicating greater deprivation [25]. The ADI has been used in prior studies tracking socioeconomic inequalities and their relationship with pediatric health outcomes [26]. The number of ambulatory visits in the study period was abstracted, as well as completion of lead screening and an annual wellness visit during that time.

Data were analyzed using IBM SPSS Statistics 23. To examine differences among the obese and nonobese cohorts, a descriptive analysis including frequencies and percentages for all categorical variables was conducted. An independent-samples *t*-test was conducted to determine a mean difference in utilization patterns between obese and nonobese patients (aim 2). Chi-square analyses were performed to understand the prevalent patterns in comorbidities among obese and nonobese children (aim 1) and to determine differences in lead screening and annual wellness visit completion among the obese and nonobese children (aim 3).

3. Results

The *mean* age of all pediatric patients in the practice was 9.89 years ($m = 9.89$; SD = 4.79) with approximately 50% female and 50% male children. Individuals from the three most common racial/ethnic categories were identified as African American/Black ($n = 1361$; 79.6%), Caucasian ($n = 181$; 10.6%), and Asian ($n = 69$; 4%). Among the entire pediatric patient panel, the three most common single medical conditions were asthma ($n = 404$; 23.6%), obesity ($n = 215$; 12.6%), and hearing loss ($n = 83$; 4.9%). A more detailed list of demographics and comorbidities is given in Table 1.

As noted previously, among the 432 ($n = 432$) pediatric patients examined further, 208 (49%) were obese and 213 (51%) were nonobese. The mean age of obese patients was 12.17 (m = 12.17; SD = 4.05), and the mean age of nonobese patients was 12 ($m = 12.34$; SD = 3.95). Both obese and nonobese children in the practice had ADIs more than one standard deviation above the mean, thus indicating above-average levels of SES deprivation. Table 2 describes the demographics of the obese and nonobese patient panel used in this study. There were no statistically significant differences between obesity and age, race, and ADIs. Sex and obesity trended toward statistical significance.

Chi-squared tests were performed to examine the relationship between obesity status and three characteristics: (1) Most Common Comorbidities, (2) Food or Medication Allergies, and (3) Medications. A significant difference was found in the following four categories in the characteristics Most Common Comorbidities: (1) No Comorbidity on File, (2) Hypertension, (3) Sleep Apnea, and (4) Environmental Allergy as shown in Table 3.

There were no statistically significant differences between obese and nonobese patients regarding their utilization patterns for

Table 1
Demographics of all Pediatric patients at Primary care practice in 2015.

Characteristics	Category	N = 1710
		n (%)
Age	2–5	420 (25%)
	6–11	591 (35%)
	12–17	699 (40%)
Sex	Female	859 (50%)
	Male	851 (49.8%)
Race	African American or Black	1361 (79.6%)
	Caucasian	181 (10.6%)
	Asian	69 (4%)
	Not Reported	74 (4.3%)
	Native Hawaiian or Other	21 (1.2%)
	American Indian or Alaskan	2 (.1%)
	Declined	2 (.1%)
Top 10 Comorbidities	Asthma	404 (23.6%)
	Obesity	215 (12.6%)
	Hearing Loss	83 (4.9%)
	Hypertension	26 (1.5%)
	Anxiety	25 (1.5%)
	Depression	24 (1.4%)
	Fatigue	20 (1.2%)
	Weight loss	19 (1.1%)
	Unspecified Fall	15 (.9%)
	Gait Instability	12 (.7%)

scheduled visits, their utilization patterns for same-day visits, or in their in-network emergency department visits as shown in Table 4.

There were no significant differences in the wellness check visits between obese ($n = 68$) and nonobese ($n = 65$) pediatric patients, χ [2](420) = 0.231, $P = .63$, or between obese ($n = 17$) and nonobese ($n = 9$) lead screening quality measures, χ [2](420) = 2.830, $P = .09$.

4. Discussion

We applied a conceptually population health-based method of analysis among pediatric patients in a large urban, academic family medicine practice. We first aggregated outpatient, emergency department, and inpatient data, with administrative SES data, to produce a nonclaims-based dataset for analysis. We then used cluster analysis to identify general trends in individual disease and comorbid disease among pediatric patients, noting high rates of conditions such as asthma and obesity. Next, we focused on differences in demographics, comorbidities, utilization, and quality of care among the obese pediatric patients and an age-matched random comparison cohort of nonobese children from within the same practice.

We found that both obese and nonobese pediatric patients in the practice had a high ADI, which indicates a high level of SES deprivation at the nine-digit zip code level. While this reflects the particular community served by the clinic system in this study, it is also consistent with the findings reported in prior literature showing an association between low SES and obesity [6]. Many EMRs have limited information on patients' SES; however, if zip code information is available, associated ADIs are publically available and can serve as a useful proxy for SES, which can be benchmarked against local, regional, and national averages [25].

Arpilleda and Paul (2012) stated that children who were overweight or obese had a higher risk for comorbidities such as asthma, sleep apnea, hypertension, type II diabetes, and depression [27]. The findings reported in the study was consistent with our findings, shown in Table 4, where sleep apnea had a higher prevalence in obese patients than in nonobese patients in the current study. Additionally, the absence of comorbidities was more common in nonobese children than in obese children.

Interestingly, more nonobese patients were reported as having environmental allergies than obese children, a finding with mixed support in the literature to date. NHANES III data from 1988 to 1994 showed no association between BMI and a heightened immune response to common allergies [28]. A study of Portuguese children by Silva et al. (2007) showed a small association between childhood BMI and atopic syndrome [29].

Multiple conditions that did not reach to the level of statistical significance were present, but these conditions were suggestive. These conditions are important to report because each condition has a potential biological connection with obesity and has been found to be associated with obesity in the literature to date. Our analysis detected an interesting relationship between obesity and lower back pain ($P = .14$), thus showing that more children who were obese were also diagnosed with lower back pain. Lower back pain has been shown in the literature to be associated with obesity. De Sa Pinto et al. (2006) conducted a cross-sectional study to determine the osteoarticular alterations in obese children and found that 55% ($P = .001$) of participants had at least one negative bone and joint biomechanical change in the lower lumbar spine due to obesity compared to nonobese children [30].

As shown in Table 3, we also found a nonsignificant but suggestive result that our obese pediatric population used the emergency room more often than nonobese children, which is

Table 2
Demographics of obese and nonobese pediatric patients at primary care practice in 2015.

Characteristics	Category	Obese	Nonobese
		(n = 208)	(n = 213)
		n (%)	*n* (%)
Age	2–5	22 (10.5%)	18 (8.5%)
	6–11	55 (26.5%)	59 (27.7%)
	12–17	131 (62.9%)	136 (64%)
Sex*	Male	94 (45.2%)	116 (54.5%)
	Female	114 (54.8%)	97 (45.5%)
Race	African American or Black	175 (84.1%)	161 (75.6%)
	White	17 (8.2%)	27 (12.7%)
	Asian	4 (1.9%)	6 (2.8%)
	Not Reported	11 (5.3%)	12 (5.6%)
	Native Hawaiian or Other Pacific Islander	1 (0.5%)	7 (3.3%)
Characteristic		**Obese (n = 208)** *m* (SD)	**Nonobese (n = 213)** *m* (SD)
Area Deprivation Index		114.72 (8.25)	113.66 (12.53)

*$P = .057$.

Table 3
Comorbidities, food or medication allergies, and medication frequencies and percentages for obese and nonobese children, 2015.

Characteristics	Category	Obese ($n = 208$)	Nonobese ($n = 213$)	χ [2]
		n (%)	n (%)	
Most Common Comorbidities	Allergic Rhinitis	70 (33%)	62 (28.6%)	.26
	Asthma	58 (27.8%)	57 (26.7%)	.79
	Dermatitis/Eczema	57 (27.4%)	52 (24.4%)	.48
	Acne	34 (16.3%)	32 (15%)	.68
	No Comorbidity on File	18 (8.6%)	37 (17.3%)	.008[b]
	Hearing Loss	13 (6.2%)	12 (5.6)	.78
	Hypertension	12 (5.7%)	2 (.93%)	.006[b]
	Iron Deficiency	12 (5.7%)	9 (4.2%)	.46
	Sleep Apnea	6 (2.8%)	1 (0.46%)	.05[a]
	Lower Back Pain	6 (2.8%)	2 (0.93%)	.14
	Depression	5 (2.4%)	5 (2.3%)	.97
	Acid Reflux	5 (2.4%)	7 (3.2%)	.58
	Environmental Allergy	1 (0.4%)	13 (6.1%)	.001[b]
Food or Medication Allergies	Dye/Other	8 (3.8%)	3 (1.4%)	.11
	Shellfish	3 (1.4%)	1 (.46%)	.30
	Peanuts	3 (1.4%)	2 (.93%)	.63
Medications	Contraceptives	9 (4.3%)	10 (4.6%)	.85
	Sinus/Environmental Allergy	19 (9.1%)	15 (7%)	.43
	Asthma/Respiratory	21 (10%)	22 (10.3%)	.93
	Dermatologic	15 (7.2%)	11 (5.1%)	.38
	Analgesic	7 (3.3%)	2 (.93%)	.08
	ADD/ADHD	2 (.96%)	6 (2.8%)	.16
	Psychiatric/Neurologic	3 (1.4%)	4 (1.8%)	.72
	Genital/Urine	2 (.96%)	1 (.46%)	.54
	Infection	1 (.4%)	1 (.46%)	.98
	Diabetes	3 (1.4%)	0	.07

[a] ≤.05
[b] <.01

Table 4
Utilization of Obese and Nonobese Pediatric Patients in our Primary Care Practice in 2015.

Characteristics	Category	Obese (n = 208)	Nonobese (n = 213)	*t*-test
		m (SD)	m (SD)	
Utilization	Routine Care	1.47 (1.24)	1.36 (.959)	.30
	Same-day Visit	0.51 (.736)	0.39 (.669)	.09
	Emergency Room	0.06 (.272)	0.02 (.152)	.06

consistent with the findings reported in literature. A study by Trasande and Chatterjee (2009) showed that obese children used the emergency room 11% more than normal-weight children [31]. Arpilleda and Paul (2012) also stated that multiple comorbidities in obese children could increase the amount of emergency room visits each year when compared to nonobese children [26].

We also found a positive correlation between analgesic medications and obesity, which is suggestive while not statistically significant ($P = .08$) in light of similar findings in the literature. Miller et al. (2010) conducted a study assessing the relationship between inpatient obese children and antimicrobial and analgesic dosing errors at a children's hospital. Miller suggested that obese children (age: 5–12 years) were at a greater risk for analgesic dosing error than nonobese children [32].

Our last interesting relationship was between obese children and diabetes medication ($P = .07$), thus indicating that more obese children were prescribed diabetes medication, potentially for "prediabetes." Childhood obesity and type II diabetes rates have increased significantly in recent years, especially in youth populations, and although the relationship was not statistically significant in our study sample, these findings suggest that it is important for primary care providers and clinics to remain vigilant about the risk of childhood-onset diabetes [33].

We are encouraged by our finding that obese and nonobese children were equally likely to meet the CHIPRA quality measures of having a wellness visit and blood lead screening, particularly given that adult patients with obesity typically have poorer overall quality of care [29]. This is likely due to population health monitoring by our practice's clinical quality team, which has included efforts to increase lead screening rates and annual wellness visit rates for all pediatric patients.

While the observations and patterns described in this study find support in the literature, they do also represent patient demographics specific to the study site. The methodology presented is nonetheless applicable to many if not most institutions and clinical settings, particularly given the increased uptake of EMRs with reporting capabilities. Our approach thereby may allow other institutions to reveal patterns among their own clinical panels, identify children with obesity and related comorbidities, and, in turn, empower clinical providers to initiate appropriate screening and intervention.

Our study represents findings from one large, academic, urban family medicine practice with a unique sample and may not be generalizable to other settings. Additionally, our sample was small and may not have been sufficiently powered to detect significant differences in comorbidities between obese and nonobese children. We also used in-network care data and did not use claims data, which would have permitted the inclusion of data on subjects' healthcare utilization at nearby centers. Finally, underdocumentation of obesity, a noted challenge in primary care [34,35], may have resulted in some patients being misclassified as nonobese.

Family medicine practices and primary care institutions may consider applying population health-based methods to identify patterns in diseases and comorbidities among their patient panels, particularly among at-risk cohorts such as obese pediatric patients.

5. Conclusion

This exploratory study examined the pediatric population of a large academic urban family medicine practice and found that the obese pediatric population had a higher prevalence of hypertension and sleep apnea and a higher total number of comorbidities, whereas nonobese children had a higher prevalence of environmental allergies. There were no statistically significant differences in single-year in-network health care utilization and selected quality measures. More research is needed to clarify potential patterns of comorbidities among at-risk pediatric patients in family medicine practices to develop targeted interventions.

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Conflicts of interest

The authors declare no conflict of interest.

Ethical statement

The study was approved by the Institutional Review Board of Thomas Jefferson University.

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