COMORBID CONDITIONS AND MEDICAID COSTS ASSOCIATED WITH CHILDHOOD OBESITY IN ARKANSAS

ACHI/Arkansas Medicaid

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Executive Summary

The prevalence of childhood obesity in Arkansas is among the highest in the U.S. By virtue of the negative association between socio-economic status and risk of obesity, Arkansas Medicaid enrollees are likely to bear a disproportionate burden from obesity-related conditions and their associated expenditures.

Previous reports from the Arkansas Center for Health Improvement (ACHI) and others have documented the effects of obesity on the likelihood of experiencing a variety of medical conditions. This report is a longitudinal assessment of obesity-associated conditions in school-aged children, the Medicaid costs related to these conditions, and the costs in early adulthood among patients who were obese in childhood. Using Arkansas school BMI assessments and Medicaid claims, we were able to identify the age at which children become obese and to describe how weight status changes as children age. We were able to identify medical conditions associated with obesity in Arkansas children, including previously described and newly identified conditions, and to describe the prevalence of these conditions at each grade level. Finally, we were able to measure the costs associated with obesity that were incurred by Medicaid during school years, as well as in current young adults who were known to be obese when they were in elementary and secondary school.

The current report found that 31.8% of Arkansas children were already overweight (16.2%) or obese (15.6%) by the time they entered Kindergarten. Overall, the rate of obesity and severity increased with each grade. Seventy-four percent of students who were obese in Kindergarten remained obese in Grade 8. In general, Hispanic children were more likely to be in higher weight status categories when compared to children in other race/ethnicity categories. Black children were represented disproportionately in the most severe obese category compared with children of other races/ethnicities. Children from lower-income households were at greater risk of obesity.

Most of the conditions found to be associated with obesity in the current report have been previously reported. In this year's report, we note that many of these conditions were associated with obesity from Kindergarten through Grade 8. We found that three conditions that have long been known to be associated with obesity in adults (hypertension, type 2 diabetes, and sleep apnea) are presenting during childhood among Arkansas's Medicaid-enrolled children and that the prevalence of these conditions increases as childhood weight increases.

This report found several associations with obesity including myopia, otitis media, bipolar disorder, and lower limb injuries. To our knowledge, the association between myopia and obesity has not been described elsewhere. The prevalence of this condition was 20% higher among obese children.

Examination of costs to Medicaid both during childhood and extending into young adulthood represent the policy and economic challenges facing efforts to combat obesity. Clear differentials exist between obese and normal weight children, particularly in early childhood (approximately $300 per year for the most severe obesity category).

By early adulthood, obesity-related conditions continue to lead to higher costs in individuals who were obese in childhood. The total annual cost of obesity among 25- to 29-year-olds was estimated to be approximately $2 million for those enrolled in an Arkansas Works Qualified Health Plan and $4 million for Medicaid Aid Category 20 (low-income parents/caretakers). It is likely that as the cohort ages and both the frequency and severity of obesity-related conditions intensify, the cost differential will continue to grow (assessments of state and public school employees suggest an approximate 25% cost differential for obese versus normal weight employees).[1] Tracking a cohort of obese individuals over time and documenting the differential and growing costs attributed to obesity-related conditions may heighten awareness, garner continued dissemination of prevention strategies, and justify clinical interventions to ameliorate lifetime health risks and associated state expenditures.

Because many children are already obese by Kindergarten, policymakers should direct programs and resources toward children and families during the prenatal period and the preschool years. Current Arkansas Department of Human Services (DHS) policies and programs to prevent childhood obesity before Kindergarten, especially those that align with the goals of Healthy Active Arkansas — a 10-year, governor-led initiative to increase the percentage of Arkansans who are at a healthy weight — should be supported and enhanced to the maximum extent possible.

Additionally, new emphasis on nutrition and physical activity programs in elementary and secondary school will be required for most obese children to achieve normal weight during school years and into adulthood. The magnitude of the obesity risk across the Arkansas population, combined with the differentials in costs, warrant consideration of efforts such as Healthy Active Arkansas to address the epidemic. Specific policy implications and suggestions related to the findings in this report are presented in the concluding section.

Background

The prevalence of childhood obesity in Arkansas is among the highest in the U.S.[2] By virtue of the negative association between socio-economic status and risk of obesity, Arkansas Medicaid enrollees have a disproportionate percentage of obesity-related conditions, which require higher healthcare expenditures to treat.[3]

In a 2018 report on “Comorbid Conditions and Medicaid Costs Associated with Childhood Obesity in Arkansas,” ACHI documented the effects of obesity on the likelihood of experiencing a variety of medical conditions. Teenagers were shown to have high rates of what previously had been adult-onset obesity-related conditions, including hypertension and diabetes. The association across various types of conditions suggested that the impact and healthcare costs of obesity were far more extensive than previously realized. The findings suggested that clinicians across a broad range of specialties should consider obesity as an associated comorbid condition among the conditions they treat.

The 2018 study, which covered a 21-month observation period, demonstrated the ability to link BMI data with Medicaid enrollment and claims data. The findings suggested that more intensive counseling and weight management strategies were warranted to avoid progression to obesity

and increased severity of the condition, once established. Findings also suggested that efforts through Healthy Active Arkansas should be supported and that short-term implications for common childhood conditions associated with obesity should be recognized.

The report recommended that future studies use a cohort for longitudinal assessment, linking school BMI data with Medicaid medical claims, to document the onset of obesity in children and to describe how obesity-associated conditions appear over time. The 2018 report concluded that "the unique ability to observe consequential tipping points — where being in an obese state for a medium to long period of time begins to erode health (e.g., development of diabetes) and increases costs of care — is ripe for future study."

Purpose of This Report

This year's report is the first longitudinal assessment of obesity-associated conditions in school-aged children, the Medicaid costs related to these conditions, and costs in early adulthood among patients who were obese during childhood. We examined Arkansas school BMI assessments, as well as Arkansas Medicaid and All-Payer Claims Database claims with the following aims:

1. To identify the age at which Arkansas children become obese and to describe how weight status changes as children grow older (Section 1);
2. To identify medical conditions associated with obesity in Arkansas children, including previously described and newly identified conditions, and to describe the prevalence of these conditions at each grade level (Section 2);
3. To measure costs of obesity incurred by Arkansas Medicaid during school years and in young adults who were known to be obese while in secondary school (Section 3); and
4. To provide 1) policy recommendations for the pre-K period, 2) clinical recommendations for obesity-associated conditions previously not described during the school-age period, and 3) the basis for estimating the early adulthood costs of conditions likely associated with childhood obesity (Section 4).

Section 1: Weight Status Presentation and Transition

METHODOLOGY

Through the passage of Act 1220 of 2003, Arkansas mandated body mass index (BMI) assessments for all public school students as part of a statewide initiative to combat childhood obesity. ACHI is the repository for longitudinal statewide BMI data. Height and weight measures are collected in grades 2, 4, 6, 8, and 10 — usually toward the end of the school year.

For this cohort study,[4] we accessed the 2003-04 through 2016-17 school year BMI assessment data and included all children in Kindergarten through Grade 8 with a valid BMI compiled from height and weight measurements. Using the 95th percentile BMI cut-points by age and gender, as recommended by the Centers for Disease Control and Prevention (CDC), children were classified as Obese. A weight status classification of Overweight was assigned to those between the 85th and 95th BMI percentiles and a classification of Normal Weight was assigned for those between the 5th and 85th BMI percentiles.

Additionally, three sub-classifications of obesity for children were assigned as proposed by Skinner et al.[5] Obese I includes children who had a calculated BMI between the 95th percentile and 20% more than the 95th percentile BMI cut-point. Obese II includes children who had a BMI between 20% more than the 95th percentile BMI cut-point and 40% more than the 95th percentile. Obese III included children with a BMI of 40% or more above the 95th percentile cut-point.

Child demographic variables were obtained from the 2015-16 school year records for all Arkansas children with valid BMI assessments. Free or reduced lunch status was included as a proxy for socio-economic status, given the known association of school lunch payment category with household income status. The majority of children covered by Medicaid were eligible for a free or reduced-price lunch.

Weight-status transition probabilities were calculated based on the population that had a valid BMI record in two consecutive measurement periods (grade-to-grade transition; results shown in the Appendix) or in both Kindergarten and Grade 8 (K-to-8 transition).

FINDINGS: DEMOGRAPHIC PROFILE

Table 1 shows the demographic profile of students based on weight status category.

TABLE 1. DEMOGRAPHIC CHARACTERISTICS BY CHILD WEIGHT STATUS (BMI CLASS) FOR 2015-16 SCHOOL YEAR

	Weight Status						
	Underweight N (%)	Normal N (%)	Overweight N (%)	Obese N (%)	Obese by Classification		
					Class I N (%)	Class II N (%)	Class III N (%)
Age							
5–8	756 (2.4)	20,186 (64.1)	5,037 (16.0)	5,516 (17.5)	3,780 (12.0)	1,294 (4.1)	442 (1.4)
9–12	682 (2.4)	15,817 (56.4)	4,829 (17.2)	6,707 (23.9)	4,299 (15.3)	1,742 (6.2)	666 (2.4)
13–19	398 (1.5)	14,666 (56.6)	4,694 (18.1)	6,139 (23.7)	3,690 (14.3)	1,667 (6.4)	782 (3.0)
Gender							
Male	1,061 (2.4)	26,107 (59.2)	7,185 (16.3)	9,716 (22.1)	6,173 (14.0)	2,502 (5.7)	1,041 (2.4)
Female	775 (1.9)	24,563 (59.4)	7,375 (17.8)	8,647 (20.9)	5,597 (13.5)	2,201 (5.3)	849 (2.1)
Race/Ethnicity							
White	1,257 (2.4)	32,894 (61.8)	8,796 (16.5)	10,307 (19.4)	6,808 (12.8)	2,560 (4.8)	939 (1.8)
Black	298 (1.8)	9,420 (56.4)	2,924 (17.5)	4,071 (24.4)	2,333 (14.0)	1,115 (6.7)	623 (3.7)
Hispanic	159 (1.5)	5,415 (50.6)	2,025 (18.9)	3,107 (29.0)	2,037 (19.0)	821 (7.7)	249 (2.3)
Other / Missing	122 (2.6)	2,941 (61.8)	815 (17.1)	878 (18.5)	592 (12.5)	207 (4.4)	79 (1.7)
Lunch Status							
Free	901 (2.0)	25,489 (56.9)	7,718 (17.2)	10,710 (23.9)	6,650 (14.8)	2,844 (6.4)	1,216 (2.7)
Reduced	185 (2.4)	4,357 (56.8)	1,339 (17.5)	1,785 (23.3)	1,120 (14.6)	475 (6.2)	190 (2.5)
Full Price	720 (2.3)	20,066 (63.3)	5,277(16.6)	5,623 (17.8)	3,843 (12.1)	1,319 (4.2)	461 (1.5)
Total Students*	1,836 (2.1)	50,670 (59.3)	14,560 (17.0)	18,363 (21.5)	11,770 (13.8)	4,703 (5.5)	1,890 (2.2)

*The number of students included in each category may not be equal to the total number of students reported because of missing data.

Note: Using the 95th percentile BMI cut-points by age and gender, children were categorized as Obese. A weight status classification of Overweight includes children between the 85th and 95th BMI percentiles. Normal Weight includes children between the 5th and 85th BMI percentiles. Underweight represents less than the 5th BMI percentile. Obese I includes children who had a calculated BMI between the 95th percentile and 20% more than the 95th percentile BMI cut-point. Obese II includes children who had a BMI between 20% more than the 95th percentile BMI cut-point and 40% more than the 95th percentile. Obese III includes children with a BMI of 40% or more above the 95th percentile cut-point.

WEIGHT STATUS AND WEIGHT STATUS TRANSITION

Overall, 15.6% of school-aged children enrolled in Kindergarten in Arkansas were over the 95th percentile and thus classified as Obese. Across all grades from Kindergarten through Grade 8, 21.5% of all school-aged children were classified as Obese. Of all obese children, one-third were in the highest risk classes — Obese II and III. By Grade 8, 3% of all children were in the Obese III (most severe) class. Sixty-one percent of children who were in the Obese III class in Kindergarten remained in this class by Grade 8. On average, children covered by Medicaid had a higher rate of obesity. Overall, 23% of Kindergarten through Grade 8 school-aged children enrolled in Medicaid were classified as Obese.

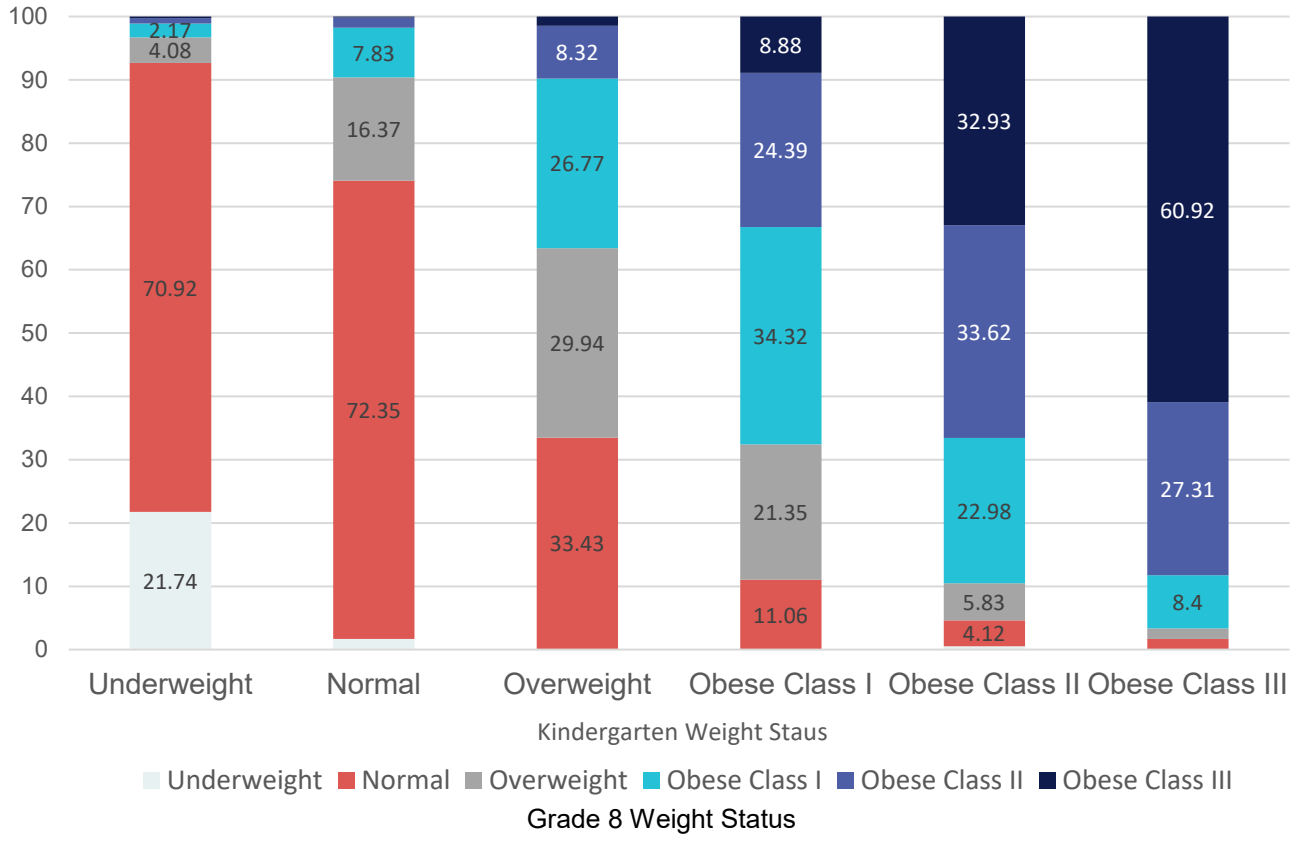
Figure 1 depicts the weight status transition from Kindergarten to Grade 8. Overall, obesity rate and Obese class severity increased with each increasing grade. Seventy-four percent of students who were Obese in Kindergarten remained Obese by Grade 8.

Children who were underweight in Kindergarten were most likely to grow into the Normal Weight class. Children who were Normal Weight in Kindergarten tended to stay in the same class by Grade 8. Children who were classified as Overweight, Obese I, or Obese II in Kindergarten were likely to stay within the same weight classification or within a range of one class higher or lower. Children who were severely Obese in Kindergarten tended to stay in the same class by Grade 8.

Analysis by race/ethnicity reveals that, in general, Hispanic children were more likely to be in higher weight status classes than children of other race/ethnicity categories. Black children were represented disproportionately in the Obese III class, compared to children of other races/ethnicities.

Black students (77%) who were Obese (Class I, II, or III) in Kindergarten were more likely than their white or Hispanic counterparts (73%) to remain Obese in Grade 8 (see Appendix). Hispanic students classified with Normal Weight status in Kindergarten were more likely than other students to become Overweight by Grade 8. Conversely, Hispanic students who were in the Obese III class in Kindergarten were more likely than their black or white counterparts to transition to Obese I or II classes. Hispanic students who were in the Obese II class in Kindergarten were less likely than other students to move up to the Obese III class by Grade 8.

FIGURE 1. TRANSITION OF WEIGHT STATUS FROM KINDERGARTEN TO GRADE 8



In this chart, each column represents the probability of Kindergarten children in a specific weight class transitioning to one of six weight classes (Underweight, Normal Weight, Overweight, Obese I, II, and III) by Grade 8. Weight status classes represented by less than 2% are not shown in the numerical label on this graph.

DISCUSSION

We determined that 31.8% of Arkansas children were already Overweight (16.2%) or Obese (15.6%) by the time they entered Kindergarten, and the majority of these Overweight and Obese children remained in these classes or became more obese by Grade 8. Home, community, and pre-school programs must be implemented during early childhood if we are going to reverse the epidemic of childhood obesity.

Likewise, intensified programs and revised requirements for school nutrition and physical activity will be required if we are going to help obese Kindergarten children achieve normal weight status during their school years. More than one in five Arkansas schoolchildren are Obese (21.5%) overall, with a higher obesity rate among children covered by Medicaid (23%), likely due to its relationship with poverty.

Children from lower income households represented by participation in free or reduced lunch programs are at greater risk — with 23.9% and 23.3% obese respectively — compared to 17.8% for children from higher income households not eligible for these programs. In addition, Hispanic school-age children are at greater risk of obesity than their white counterparts, with 29% and 19.4% obese, respectively.

Section 2: Conditions Associated with Obesity

METHODOLOGY

Students with valid height and weight assessments and who had near-continuous Medicaid eligibility in two calendar years (a maximum gap of one month in each year was permitted) containing a BMI measurement school year were linked using a unique individual identifier compiled at ACHI. Medicaid claims records from January 1, 2007, to September 15, 2017, were extracted from medical, pharmacy, and hospital claims.

Conditions potentially related to obesity were identified by using the Healthcare Cost and Utilization Project (HCUP) Clinical Classifications Software (CCS) for ICD-9-CM and for ICD-10-CM. Through the use of CCS, we were able to cluster ICD-9/10-CM into manageable numbers of categories and pre-determine analyzable numbers of conditions for a further investigation. We implemented this data-driven and clinically agnostic approach in order to discover potential obesity-related conditions undetected in previous studies. To minimize the inclusion of diagnostic coding errors, children were required to have at least two claims with the same identified clinical conditions in order to be flagged as having received treatment for that diagnosis.

After identifying patients with each of the CCS conditions, we calculated prevalence rates for obese and normal weight children in each grade. Overall prevalence of conditions were gender-adjusted for children in each grade to account for possible disproportionate distribution of clinical conditions between genders. CCS categories for which an association with obesity was concluded were further broken into smaller categories/diagnoses when greater clinical precision was warranted.

FINDINGS: FREQUENCY AND ODDS RATIO OF SELECTED CONDITIONS

Table 2 provides gender-adjusted odds ratios among eighth grade children for CCS conditions or more detailed diagnoses (when CCS captured too broad a set of diagnoses) for which there were at least 100 children in the Obese category with the specified condition. Additionally, the prevalence of these conditions had to be at least 20% higher (i.e., odds ratio [OR]>1.2) in Obese children, when compared to Normal Weight children.

TABLE 2. GENDER-ADJUSTED ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR SELECTED CONDITIONS IN GRADE 8

Conditions	Weight Status															
	Normal (17,983)	Overweight (6,324)			Obese (8,909)			Obese by Classification								
								Class I (5,140)			Class II (2,479)			Class III (1,290)		
	N	N	OR	LCI UCI	N	OR	LCI UCI	N	OR	LCI UCI	N	OR	LCI UCI	N	OR	LCI UCI
Essential Hypertension	46	25	1.6	1.0 2.6	147	6.6	4.7 9.2	47	3.6	2.4 5.4	44	7.1	4.7 10.7	56	18.1	12.2 26.8
Ingrowing Nail	125	73	1.7	1.3 2.3	172	2.8	2.2 3.6	99	2.8	2.2 3.7	52	3.1	2.2 4.3	21	2.4	1.5 3.8
Otitis Media/Eustachian Tube Disorder	331	148	1.3	1.0 1.5	343	2.1	1.8 2.5	170	1.8	1.5 2.2	100	2.2	1.8 2.8	73	3.2	2.5 4.1
Skin Infections	437	204	1.3	1.1 1.6	384	1.8	1.6 2.1	204	1.7	1.4 2.0	119	2.0	1.6 2.5	61	2.0	1.5 2.6
Esophageal Reflux	146	48	0.9	0.7 1.3	117	1.6	1.3 2.1	62	1.5	1.1 2.0	29	1.4	1.0 2.2	26	2.5	1.6 3.8
Bronchitis/Bronchiolitis	220	90	1.2	0.9 1.5	159	1.5	1.2 1.8	88	1.4	1.1 1.8	51	1.7	1.2 2.3	20	1.3	0.8 2.0
Joint Disorders and Dislocations	208	86	1.2	0.9 1.5	147	1.4	1.2 1.8	95	1.6	1.3 2.1	40	1.4	1.0 2.0	12	0.8	0.4 1.4
Acute/Chronic Sinusitis	813	330	1.1	1.0 1.3	561	1.4	1.3 1.6	289	1.3	1.1 1.4	179	1.6	1.4 1.9	93	1.6	1.3 2.0
Asthma	734	286	1.1	1.0 1.3	504	1.4	1.3 1.6	254	1.2	1.1 1.4	156	1.6	1.3 1.9	94	1.9	1.5 2.3
Allergic Rhinitis Due to Pollen	832	317	1.1	0.9 1.2	566	1.4	1.3 1.6	305	1.3	1.1 1.5	171	1.5	1.3 1.8	90	1.5	1.2 1.9
Allergy	300	149	1.4	1.1 1.7	207	1.4	1.2 1.7	115	1.3	1.1 1.7	66	1.6	1.2 2.1	26	1.2	0.8 1.8
Bipolar Disorder	209	85	1.2	0.9 1.5	143	1.4	1.1 1.7	79	1.3	1.0 1.7	43	1.5	1.1 2.1	21	1.4	0.9 2.2
Lower Limb Injury	886	405	1.3	1.2 1.5	593	1.4	1.2 1.5	336	1.4	1.2 1.5	159	1.3	1.1 1.6	98	1.6	1.3 2.0
Menstrual Disorders	488	183	0.9	0.8 1.1	331	1.4	1.2 1.6	179	1.3	1.1 1.5	98	1.5	1.2 1.8	54	1.5	1.1 2.0
Astigmatism	775	342	1.2	1.1 1.4	519	1.4	1.2 1.5	281	1.3	1.1 1.5	138	1.3	1.1 1.6	100	1.9	1.5 2.3
Acute Upper Respiratory Infections of Unspecified Site	740	301	1.1	1.0 1.3	491	1.4	1.2 1.5	279	1.3	1.2 1.5	126	1.2	1.0 1.5	86	1.7	1.3 2.1
Tonsillitis	156	70	1.2	0.9 1.6	104	1.3	1.0 1.7	58	1.3	1.0 1.8	31	1.4	1.0 2.1	15	1.3	0.8 2.2
Depression	1464	597	1.1	1.0 1.3	902	1.3	1.2 1.4	480	1.2	1.0 1.3	262	1.3	1.2 1.5	160	1.6	1.3 1.9
Back pain	464	175	1.1	0.9 1.3	286	1.3	1.1 1.5	162	1.2	1.0 1.5	85	1.3	1.1 1.7	39	1.2	0.8 1.6
Myopia	1918	768	1.1	1.0 1.2	1156	1.2	1.2 1.3	660	1.2	1.1 1.4	323	1.3	1.1 1.4	173	1.3	1.1 1.5

Abbreviations: OR = Odds Ratio; LCI = Lower 95% confidence interval; UCI = Upper 95% confidence interval.

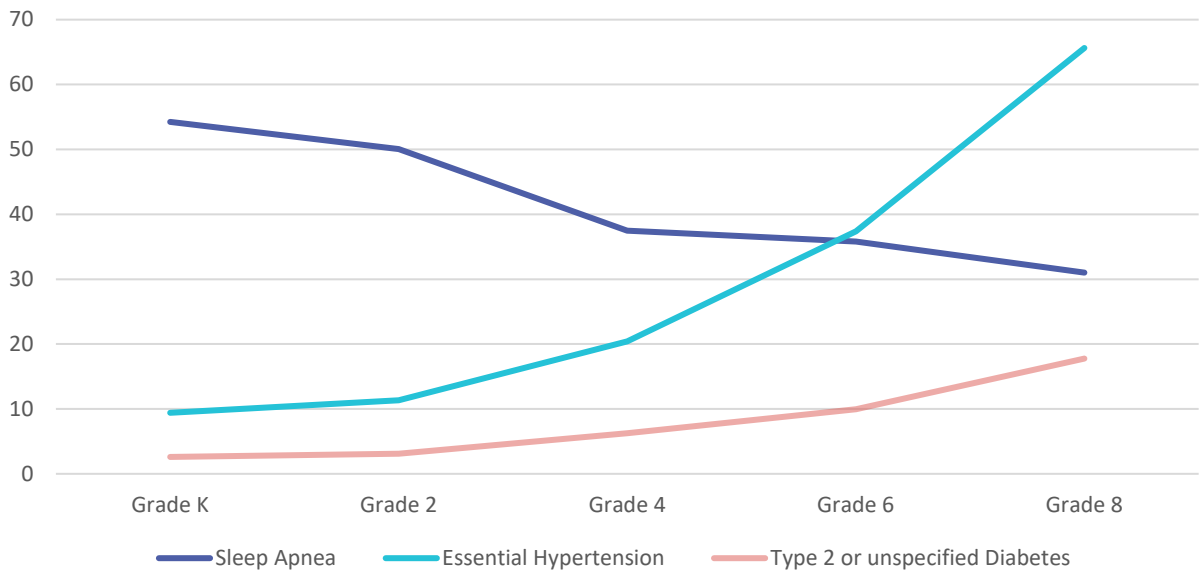
CONDITIONS PREVIOUSLY KNOWN TO BE ASSOCIATED WITH OBESITY

Most of the conditions displayed in Table 2 were noted to be associated with obesity in our previous year's report. In this report, we note that some of these conditions were associated with obesity as early as Kindergarten and continued to be associated through Grade 8. These included tonsillitis, acute bronchitis, sinusitis, allergy, asthma, respiratory infections, joint disorders, back pain, ingrowing nail, skin infections, and astigmatism.

In addition to the conditions displayed in Table 2, the current study found less common but important conditions, such as sleep apnea, essential hypertension, and type 2 diabetes where the odds ratio of prevalence was at least 20% higher in Obese children compared with Normal Weight children.

Figure 2 displays the overall prevalence of sleep apnea, essential hypertension, and type 2 diabetes by school grade.

FIGURE 2. PREVALENCE OF SLEEP APNEA, ESSENTIAL HYPERTENSION, AND TYPE 2 DIABETES (PER 10,000 CHILDREN) BY GRADE

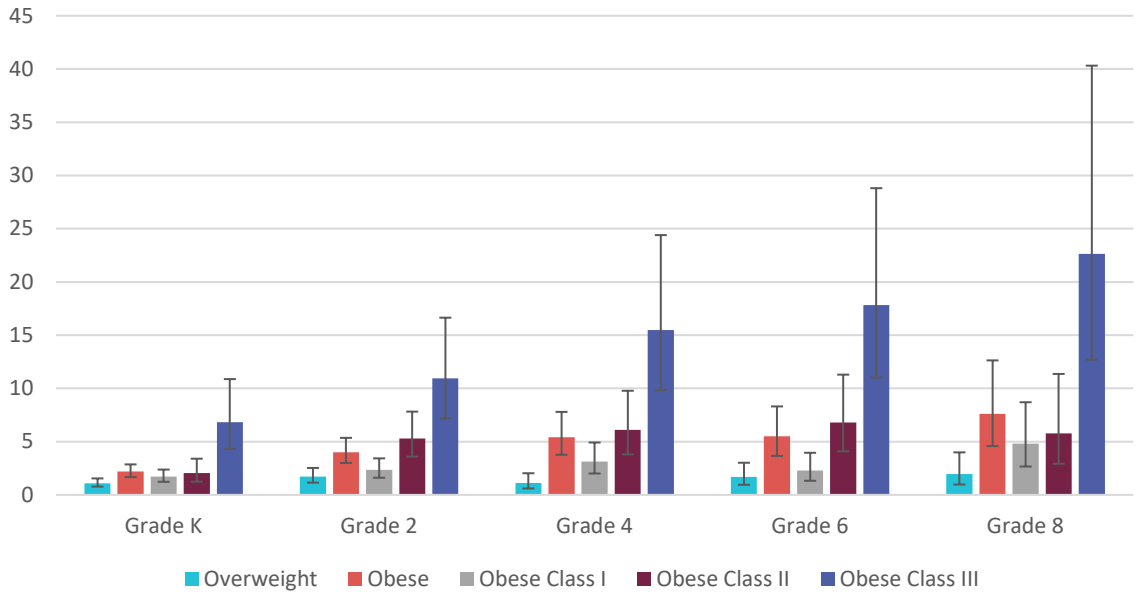


Sleep Apnea

The association between obesity and sleep apnea is well known and was noted in last year's report under the category "obesity hypoventilation syndrome." This year's report shows that the prevalence rate of sleep apnea declines in all weight classes as children grow older. The high prevalence of sleep apnea among young children is usually due to enlargement of the adenoids and tonsils relative to the size of the airways. Growth in airway size ameliorates sleep apnea risk in normal weight children as they age.

Our data show that sleep apnea increased ($p<0.001$) as the severity of obesity increased, regardless of age. In Kindergarten, Obese children were 2.1 times as likely to be diagnosed with sleep apnea compared to Normal Weight children. In Grade 8, compared to Normal Weight children, Obese children were 7.6 times as likely to have sleep apnea. When the Obese class is sub-divided, children in Grade 8 in Obese classes I, II, and III were 4.8, 5.8, and 22.6 times as likely, respectively, to have sleep apnea compared to Normal Weight children.

FIGURE 3. SLEEP APNEA BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)

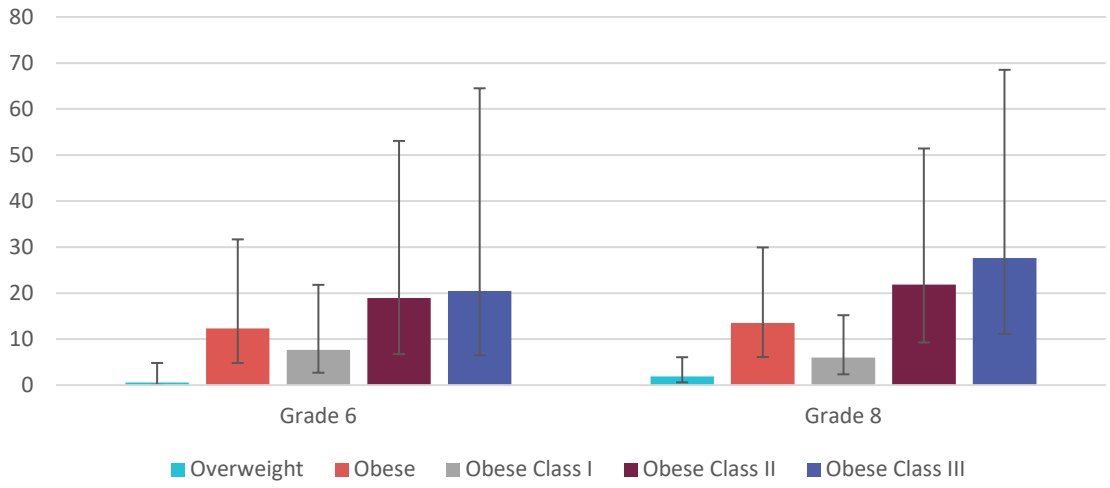


Type 2 Diabetes

Type 2 diabetes in childhood is well known to be caused by obesity and was rarely observed until the recent epidemic of childhood obesity. Our data show that the prevalence rate of type 2 diabetes increased significantly from Kindergarten through Grade 8 and further increased as the severity of obesity increased. In Grade 6, Obese children were 12.3 times as likely to be diagnosed with type 2 diabetes as Normal Weight children. When the Obese class is sub-divided, children in Obese classes I, II, and III were 7.7, 18.9, and 20.4 times as likely, respectively, to have type 2 diabetes compared to Normal Weight Children.

In Grade 8, Obese children were 13.5 times as likely to be diagnosed with type 2 diabetes compared to Normal Weight children. When the Obese class is sub-divided, children in Obese classes I, II, and III were 6.0, 21.8, and 27.6 times as likely as Normal Weight children, respectively, to have type 2 diabetes.

FIGURE 4. TYPE 2 DIABETES BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)

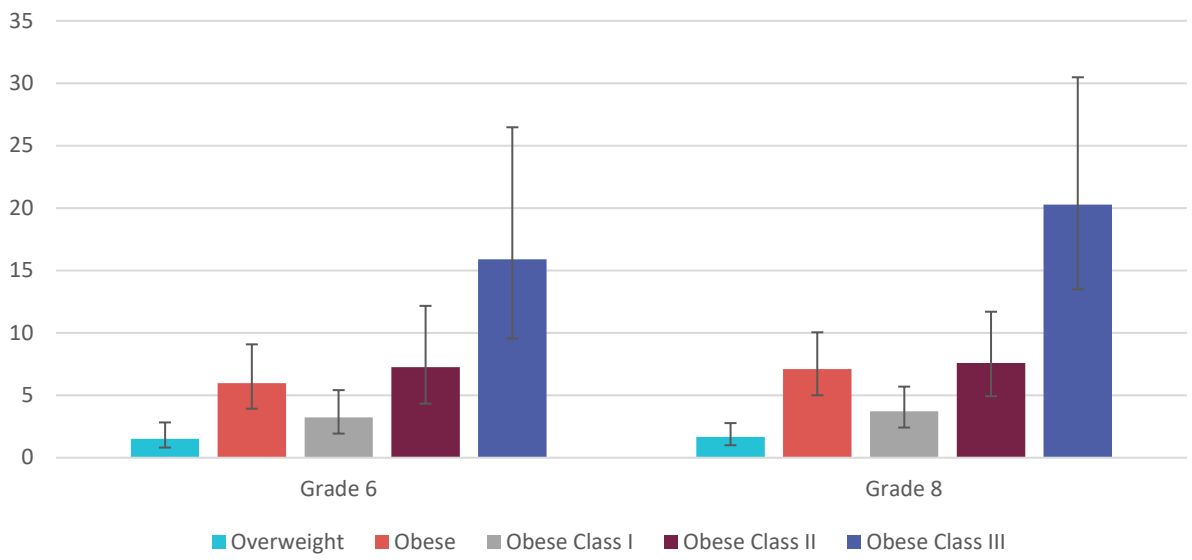


Essential Hypertension

The association between childhood essential hypertension and obesity is well documented. Our data show that the prevalence rate of essential hypertension increased significantly from Kindergarten through Grade 8 and further increased as the severity of obesity increased. In Grade 6, Obese children were six times as likely to be diagnosed with essential hypertension as were Normal Weight children. Children in Obese classes I, II, and III were 3.2, 7.5, and 15.9 times as likely, respectively, to have essential hypertension, compared to Normal Weight children.

In Grade 8, Obese children overall were 7.1 times as likely to be diagnosed with essential hypertension compared to Normal Weight children. When the Obese class is sub-divided, children in Obese classes I, II, and III were 3.7, 7.6, and 20.3 times as likely, respectively, to have essential hypertension, compared to Normal Weight children.

FIGURE 5. ESSENTIAL HYPERTENSION BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)



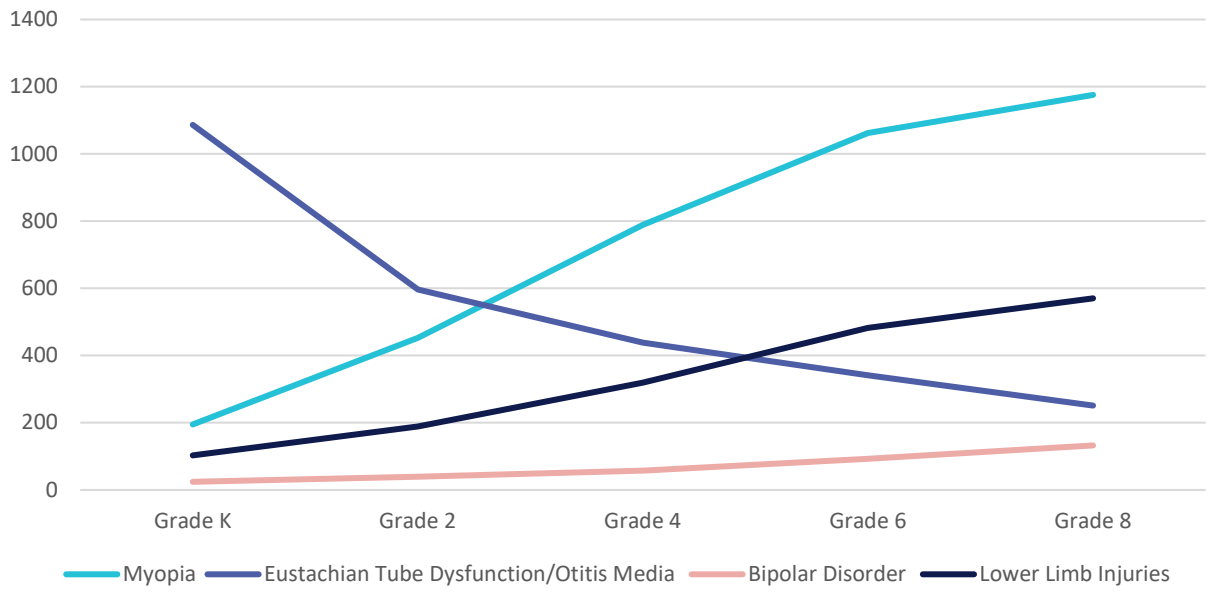
DISCUSSION

Sleep apnea, essential hypertension, and type 2 diabetes are conditions that have been known to be associated with obesity in adults. The clinical and social burden from these conditions is among the highest of any adult disorders. While the prevalence for these conditions is not as high in childhood, and while the complications from these conditions may not manifest until adulthood, it is clear from our data that these obesity-related conditions begin in childhood and that the prevalence of these conditions increase with increasing childhood weight. Because a majority of obese children maintain obesity status into adulthood, intervention during pre-school and subsequent school years to reduce obesity rates may reduce the development of these and other costly conditions.

OBESITY-ASSOCIATED CONDITIONS NEWLY IDENTIFIED IN THIS REPORT

In this report, we observed several new conditions associated with obesity that were not included in the previous year's report. Most notable among these were myopia, bipolar disorder (BD), eustachian tube disorder/otitis media (ET/OM), and lower limb injuries. From our review of the literature, it appears that the association of childhood obesity with myopia has not been described previously.

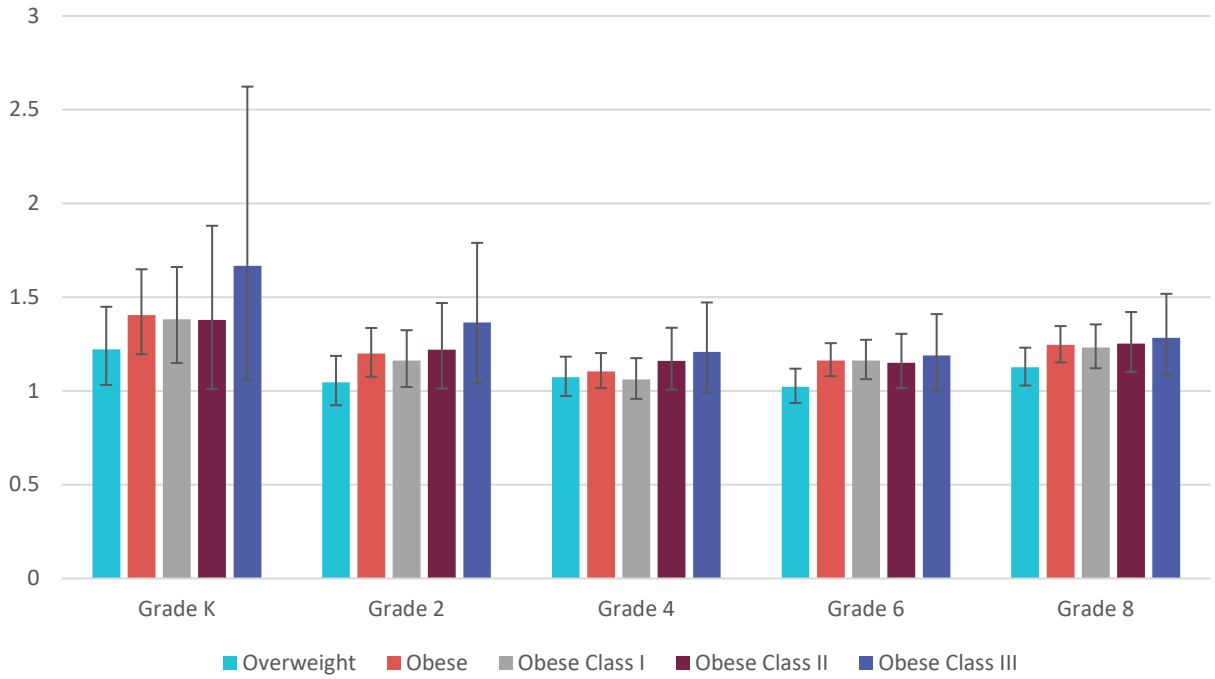
FIGURE 6. PREVALENCE OF MYOPIA, BIPOLAR DISORDER, EUSTACHIAN TUBE DISORDER/OTITIS MEDIA, AND LOWER LIMB INJURIES (PER 10,000 CHILDREN) BY GRADE



Myopia

Our data show that the prevalence rate of myopia increased from Kindergarten through Grade 8 (Figure 6), and generally further increased as the severity of obesity increased (Figure 7).

FIGURE 7. MYOPIA BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)



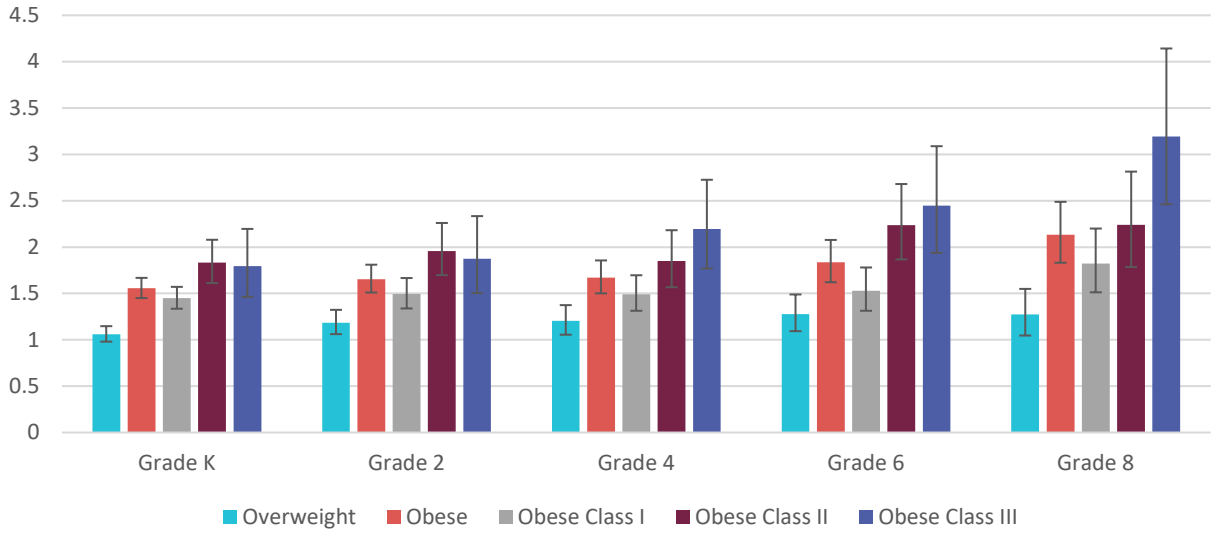
In Kindergarten, Obese children overall were 1.4 times as likely to be diagnosed with myopia compared to Normal Weight children. Children in Obese classes I, II, and III were 1.4, 1.4, and 1.7 times as likely, respectively, to have myopia compared to Normal Weight children.

In Grade 8, Obese children overall were 1.2 times as likely to be diagnosed with myopia compared to Normal Weight children. When the Obese class is sub-divided, children in Obese classes I, II, and III were 1.2, 1.3, and 1.3 times as likely as Normal Weight children, respectively, to have myopia.

Eustachian Tube Dysfunction/Otitis Media (ET/OM)

The prevalence rate of ET/OM declined in higher grades (Figure 6), but Obese children were more likely to be diagnosed with ET/OM in any grade, when compared with Normal Weight children ($p<0.001$).

FIGURE 8. EUSTACHIAN TUBE DYSFUNCTION/OTITIS MEDIA BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)



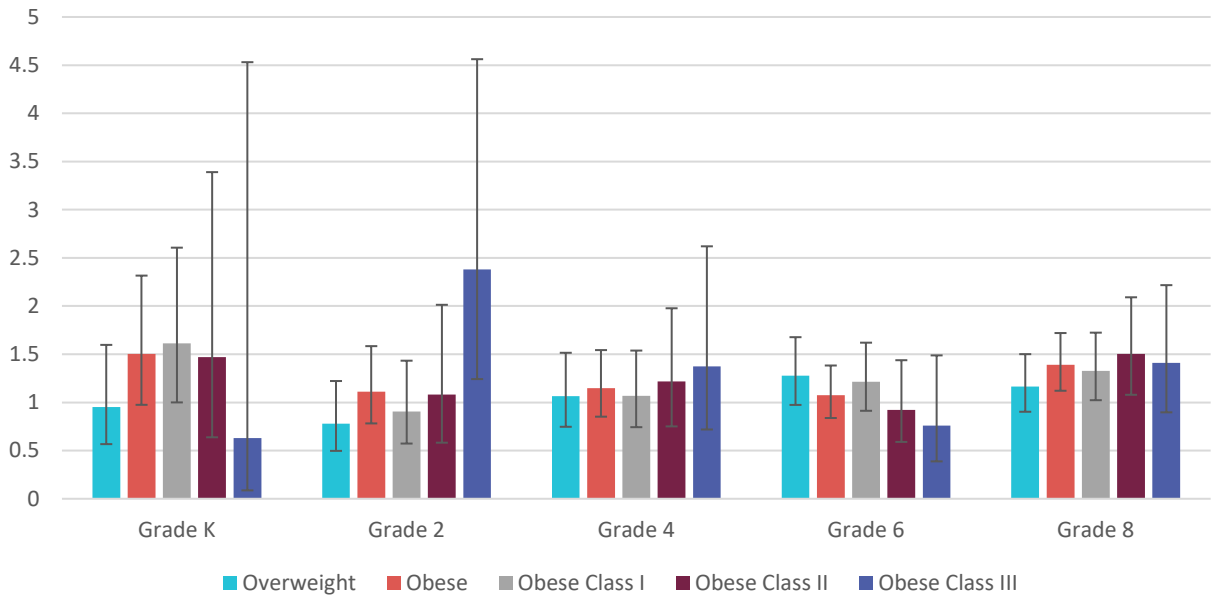
Our data show that the prevalence of ET/OM increased as the severity of obesity increased. In Kindergarten, Obese children overall were 1.6 times as likely to be diagnosed with ET/OM compared to Normal Weight children. Children in Obese classes I, II, and III were 1.4, 1.8, and 1.8 times as likely, respectively, to have ET/OM compared to Normal Weight children.

In Grade 8, Obese children overall were 2.1 times as likely as Normal Weight children to be diagnosed with ET/OM. When the Obese class is sub-divided, children in Obese classes I, II, and III were 1.8, 2.2, and 3.2 times as likely, respectively, to have ET/OM compared to Normal Weight children.

Bipolar Disorder

For bipolar disorder, the difference between Obese and Normal Weight children is statistically significant only for Grade 8 (Figure 9). Bipolar disorder is rarely diagnosed in early grades because diagnostic criteria usually do not apply to very young children.

FIGURE 9. BIPOLAR DISORDER BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)

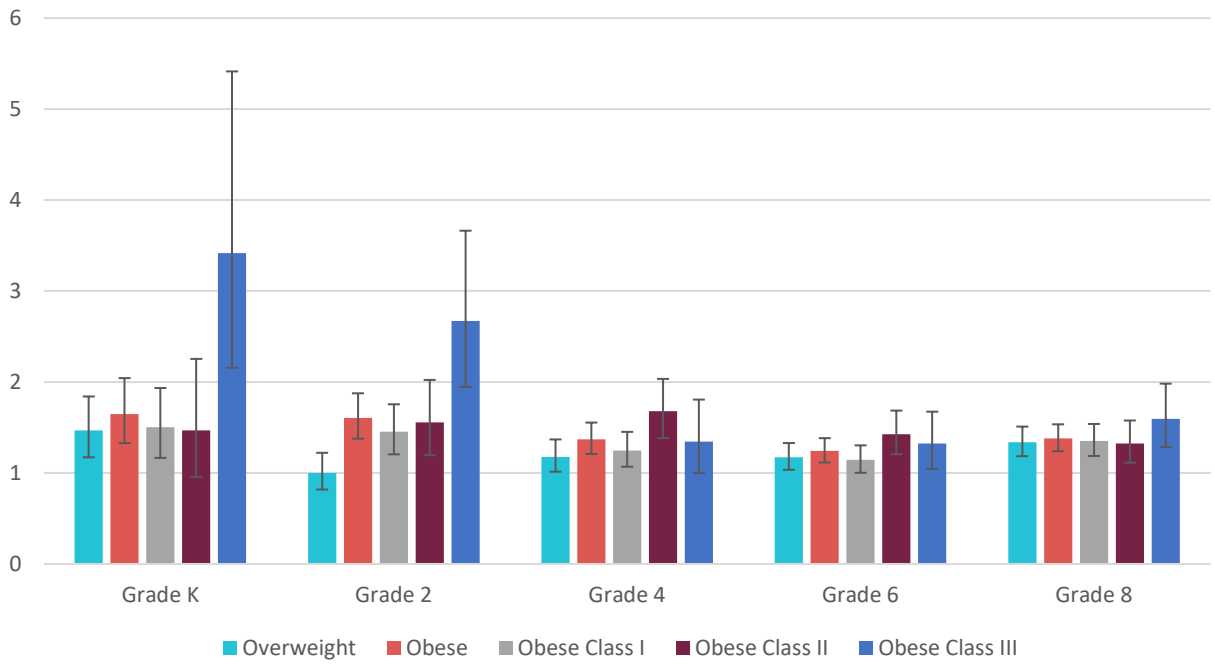


In Grade 8, Obese children overall were 1.4 times as likely to be diagnosed with bipolar disorder compared to Normal Weight children. When the Obese class is sub-divided, children in Obese classes I, II, and III were 1.3, 1.5, and 1.4 times as likely, respectively, to have bipolar disorder compared to Normal Weight children.

Lower Limb Injuries

Our data show that the prevalence rate of lower limb injuries increased from Kindergarten through Grade 8 (Figure 10).

FIGURE 10. LOWER LIMB INJURIES BY GRADE AND WEIGHT STATUS (ODDS RATIO AND 95% CONFIDENCE INTERVAL BANDS WITH NORMAL WEIGHT AS REFERENT CLASS)



In Kindergarten, Obese children overall were 1.6 times as likely to be diagnosed with lower limb injuries compared to Normal Weight children. Children in Obese classes I, II, and III were 1.5, 1.5, and 3.4 times as likely, respectively, to have lower limb injuries compared to Normal Weight children.

In Grade 8, compared to Normal Weight children, Obese children overall were 1.4 times as likely to be diagnosed with lower limb injuries. When the Obese class is sub-divided, children in Obese classes I, II, and III were 1.4, 1.3, and 1.6 times as likely, respectively, to have lower limb injuries compared to Normal Weight children.

DISCUSSION

Using a larger population and tracking more clinical conditions, this report includes several new associations of clinical conditions with childhood obesity than was described in our previous year's report. Several new associations were noted for clinical conditions that may have important policy, clinical, and research implications.

A review of the literature suggests that the association between myopia and obesity has not been described previously. The 20% higher prevalence of this condition among Obese children (30% in Obese class III) suggests the importance of screening obese children early and frequently for this condition. We also found that Obese children were 20% more likely (Odds Ratio [OR]: 1.2, confidence interval [CI]: 1.2-1.3) to have had an eye and vision examination than Normal Weight children, and Obese class III children were 40% more likely (OR: 1.4, CI: 1.2-1.6) to have had these exams. This plausibly reflects the higher prevalence of myopia and astigmatism among Obese children.

Despite the additional costs to Medicaid for eye exams and corrective eyewear, children with undiagnosed myopia are likely to experience academic performance deficiencies related to this condition.

An association between otitis media and obesity was not included in the last year's report, but this association has been described previously in the literature.[6,7,8] Using CCS categories to identify possible associations with obesity and combining otitis media ICD-9/10-CM codes with eustachian tube disorder codes for this report, we noted a clear association of these conditions with obesity. As expected, ET/OM prevalence decreased with grade as the anatomy and exposures changed, but the association of these conditions with obesity was present in all grades. This suggests that obesity may have a causal role in ET/OM. Plausibly, increased adipose tissue around the eustachian tube could alter the anatomy in such a way as to prevent normal function.

A preliminary association between childhood obesity and bipolar disorder has been observed in two studies but has not been well described. In a 2008 study of 348 children with bipolar disorder, the authors found that "overweight/obesity was prevalent among 42% of subjects" and concluded, "the prevalence of overweight/obesity among youth with bipolar disorder may be modestly greater than in the general population." [9]

A 2010 study of comorbid conditions among 1,841 children and adolescents diagnosed with bipolar disorder found that obesity was one of 10 conditions examined that was significantly more prevalent in the bipolar disorder cohort.[10]

In this report, we have noted an association of bipolar disorder with obesity only in children who are in Grade 8. Obese children were 40% more likely to have a diagnosis of bipolar disorder compared to Normal Weight children in Grade 8. The association was not observed in earlier grades and may be due, in part, to the difficulty of diagnosing this disorder in children. Additionally, the low prevalence in young children may preclude the ability to ascertain statistical differences. Further research may help reveal the reason for the association between obesity and this condition.

There is ample evidence in the literature to show an association between childhood obesity and lower limb injuries.[11]

A 2013 population-based, cross-sectional study from the electronic medical records of 913,178 patients aged 2 to 19 years concluded that increasing BMI is associated with increased odds of foot, ankle, leg, and knee fractures in children.[12]

Although the association between obesity and lower limb injuries was not noted in last year's report, the current report shows an association in all grades. The higher risk seen in Kindergarten (60% higher among Obese children compared to Normal Weight children) than in Grade 8 (40% higher risk) could reflect a less frequent involvement in activities that are likely to lead to lower limb injuries among Obese children as they get older and more sedentary.

Section 3: Medicaid Costs of Obesity in Children and Young Adults

METHODOLOGY

Child healthcare costs were calculated from Medicaid claims experience temporally associated with BMI collection. In order to evaluate any potential increase in the cost of healthcare experienced by obese children, the median cost of AR Kids A and B beneficiaries were calculated separately, based on their weight status. Hospital cost calculations were restricted to inpatient hospital facilities only and specifically excluded inpatient psychiatric and substance abuse facilities. Supplemental payments to hospitals for inpatient and outpatient services were not included and therefore overall estimated costs may be lower than the true cost to Medicaid. Cost calculations were based on all children who were continuously enrolled in AR Kids A or B in 2016 with one allowable gap of one month.

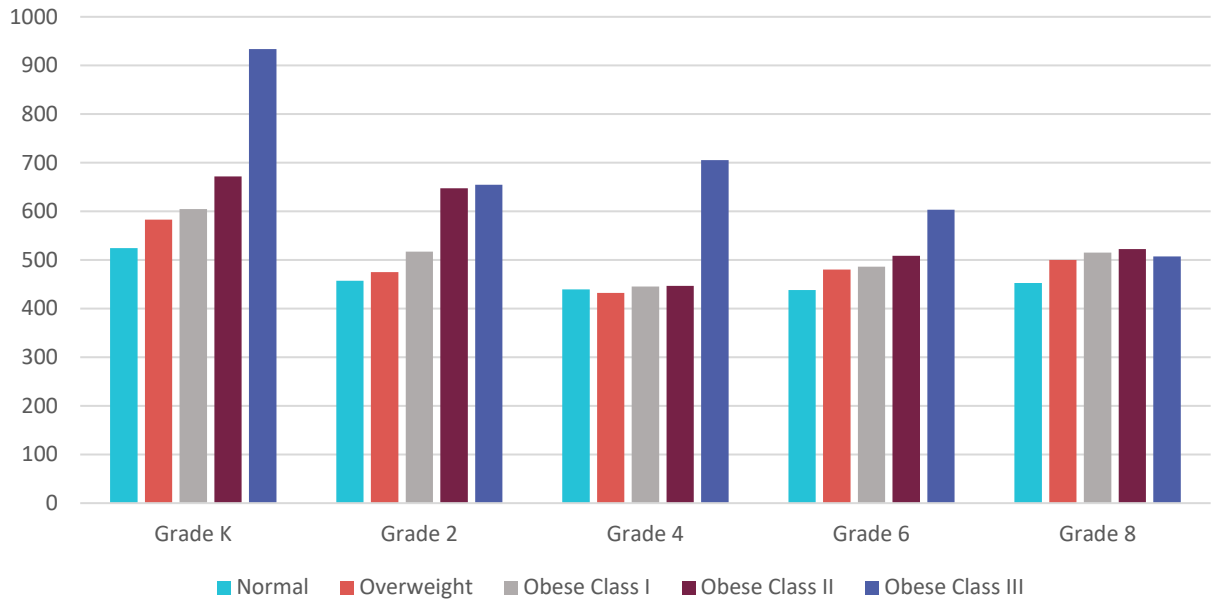
Young adult (25-29 years of age) healthcare costs associated with childhood weight status (obtained from last weight status in School BMI data) were obtained from Medicaid claims data and the Arkansas All-Payer Claims Database. From these data sources, two Medicaid cohorts were studied; those enrolled in Medicaid Aid Category 20 (low-income parents/caretakers) and the Medicaid expansion population covered by a Qualified Health Plan (QHP) in 2016. Medicaid claims for all women experiencing pregnancy in 2016 (ICD-10-CM: Z33, Z34, Z36, Z37, Z38 codes) were excluded from analysis. Median costs (with associated inter-quartile range) of young adults are reported separately by the last weight status category derived in Grade 7–10.

FINDINGS: COST CALCULATION

Obesity Impact on AR Kids A and B

The median incremental healthcare costs attributable to increasing weight status category is positive but small (data not shown). However, once a child reaches obese status, there is a more pronounced increase in median healthcare costs per child as the severity of obesity status increases (Figure 11).

FIGURE 11. MEDICAID AR KIDS A AND B MEDIAN HEALTHCARE COSTS BY GRADE AND WEIGHT STATUS



Young Adult Healthcare Costs by Last Measured High School Weight Status

In Table 3, the demographic characteristics of the young adult population enrolled in Medicaid Aid Category 20 and QHP beneficiaries in 2016 are presented by their last recorded weight status in high school.

TABLE 3. DEMOGRAPHIC CHARACTERISTICS BY CHILD WEIGHT STATUS (BMI CLASS) AT LAST MEASUREMENT OF AID CATEGORY 20 AND QHP ENROLLEES

		Weight Status						
		Underweight N (%)	Normal N (%)	Overweight N (%)	Obese N (%)	Obese by Classification		
						Class I N (%)	Class II N (%)	Class III N (%)
Grade at Measurement								
7		12 (1.5)	400 (48.6)	176 (21.4)	235 (28.6)	135 (16.4)	64 (7.8)	36 (4.4)
8		15 (0.9)	930 (53.6)	308 (17.8)	482 (27.8)	242 (14.0)	154 (8.9)	86 (5.0)
9		37 (1.1)	1,840 (53.5)	635 (18.5)	927 (27.0)	521 (15.2)	251 (7.3)	155 (4.5)
10		76 (1.4)	3,101 (55.0)	991 (17.6)	1,466 (26.0)	806 (14.3)	422 (7.5)	238 (4.2)
Gender								
Male		70 (1.4)	2,766 (54.4)	820 (16.1)	1,428 (28.1)	762 (15.0)	422 (8.3)	244 (4.8)
Female		70 (1.1)	3,505 (53.5)	1,290 (19.7)	1,682 (25.7)	942 (14.4)	469 (7.2)	271 (4.1)
Race / Ethnicity								
White		100 (1.5)	3,656 (55.5)	1,132 (17.2)	1,695 (25.8)	958 (14.6)	487 (7.4)	250 (3.8)
Black		31 (0.7)	2282 (51.8)	854 (19.4)	1,238 (28.1)	637 (14.5)	356 (8.1)	245 (5.6)
Hispanic		--	172 (50.3)	71 (20.8)	95 (27.8)	57 (16.7)	28 (8.2)	--
Other / Missing		--	161 (53.5)	53 (17.6)	82 (27.2)	52 (17.3)	20 (6.6)	--
Lunch Status								
Free		73 (1.1)	3,364 (52.3)	1,213 (18.8)	1,787 (27.8)	934 (14.5)	525 (8.2)	328 (5.1)
Reduced		13 (1.2)	561 (53.5)	176 (16.8)	298 (28.4)	175 (16.7)	77 (7.4)	46 (4.4)
Full Price		52 (1.3)	2,281 (56.6)	701 (17.4)	998 (24.8)	577 (14.3)	282 (7.0)	139 (3.5)
Plan/Payer								
Medicaid		16 (0.8)	1,161 (56.1)	377 (18.2)	516 (24.9)	314 (15.2)	139 (6.7)	63 (3.0)
QHP	QualChoice	16 (0.9)	1,020 (56.1)	299 (16.5)	482 (26.5)	254 (14.0)	148 (8.2)	80 (4.4)
QHP	Centene	26 (1.5)	995 (56.1)	309 (17.4)	444 (25.0)	252 (14.2)	119 (6.7)	73 (4.1)
QHP	BCBS	82 (1.4)	3,095 (51.8)	1,125 (18.8)	1,668 (27.9)	884 (14.8)	485 (8.1)	299 (5.0)
Total		140 (1.2)	6,271 (53.9)	2,110 (18.1)	3,110 (26.7)	1,704 (14.7)	891 (7.7)	515 (4.4)

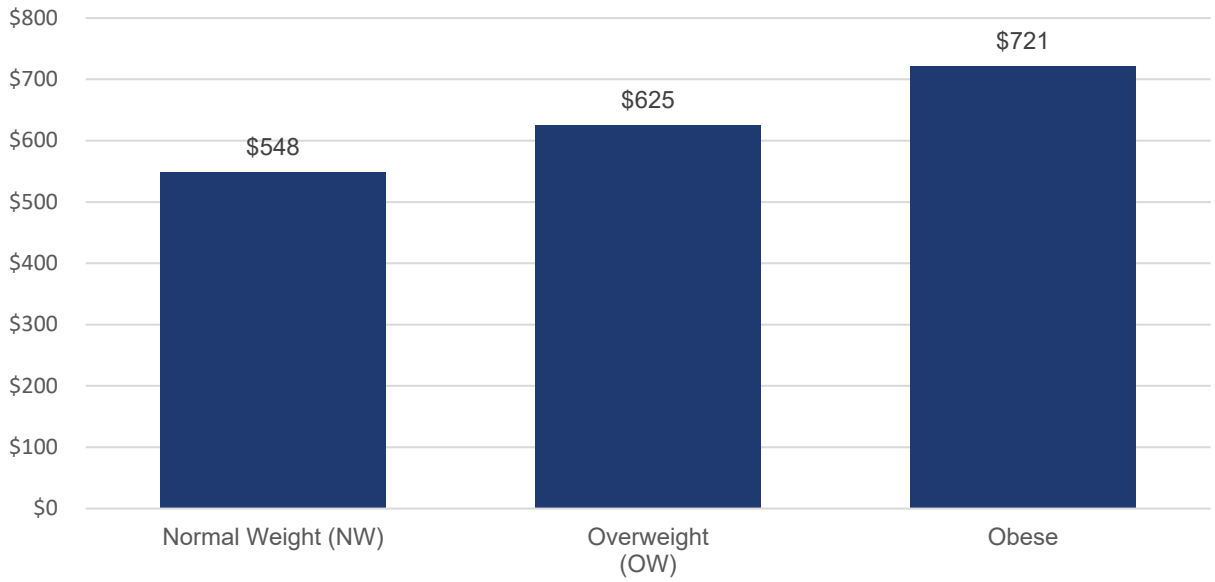
*The number included in each category may not be equal to the total number of students reported because of missing data. Weight categories represent the last valid weight and height measurement on record prior to Grade 11. Measurements from Grades 11-12 were not used due to the potential bias in assessment. Those who experienced pregnancy in the observation year were removed from this analysis.

Notes: Cells with "--" indicate cell population numbers less than 11 and have been suppressed; QHP = Qualified Health Plan; BCBS = Blue Cross Blue Shield. Using the 95th percentile BMI cut-points by age and gender, children were categorized as Obese. A weight status classification of Overweight includes children between the 85th and 95th BMI percentiles. Normal Weight includes children between the 5th and 85th BMI percentiles. Obese I includes children who had a calculated BMI between the 95th percentile and 20% more than the 95th percentile BMI cut-point. Obese II includes children who had a BMI between 20% more than the 95th percentile BMI cut-point and 40% more than the 95th percentile. Obese III includes children with a BMI of 40% or more above the 95th percentile cut-point.

Traditional Medicaid Aid Category 20

Figure 12 depicts the 2016 median healthcare costs for young adults (25-29 years of age) enrolled in Medicaid Aid Category 20 by last measured weight status in middle or high school.

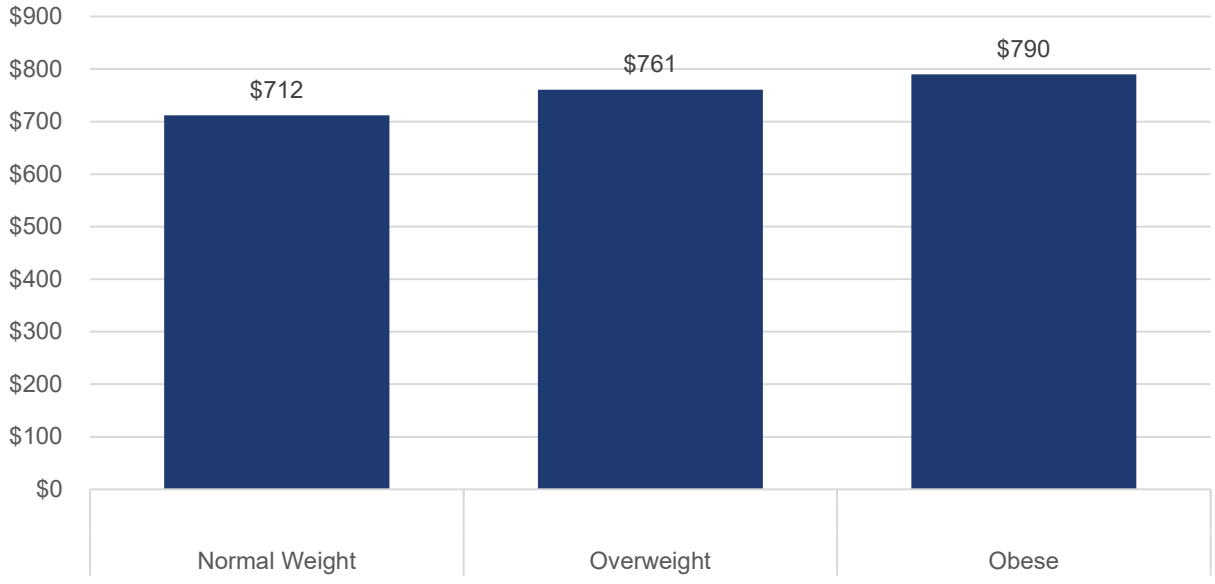
FIGURE 12. 2016 MEDICAID AID CATEGORY 20 ENROLLEE (25-29 YEARS OF AGE) MEDIAN HEALTHCARE COSTS BY LAST MEASURED SECONDARY SCHOOL WEIGHT STATUS



QHP Beneficiaries

Figure 13 depicts the 2016 median healthcare costs for young adults (25-29 years of age) enrolled in a Qualified Health Plan by last measured weight status in high school.

FIGURE 13. 2016 QUALIFIED HEALTH PLAN ENROLLEE (25-29 YEARS OF AGE) MEDIAN HEALTHCARE COSTS BY LAST MEASURED SECONDARY SCHOOL WEIGHT STATUS



EXCESS ATTRIBUTABLE COSTS OF OBESITY TO MEDICAID AMONG YOUNG ADULTS

To estimate the excess attributable cost of obesity to Medicaid for 25- to 29-year-olds enrolled in Medicaid Aid Category 20 or a Medicaid expansion QHP, the mean incremental cost of obesity was calculated and applied to the estimated number of obese 25- to 29-year-olds enrolled in each of these Medicaid programs.

As noted above, obesity status was projected from the latest school-age BMI for 25- to 29-year-olds for whom claims were paid by Medicaid or QHPs. Pregnancy costs were not included and the 1% of individuals with the high outlying claims costs were removed to avoid undue influence by conditions unlikely to be related to obesity (e.g., trauma). Marginal costs were calculated separately for Medicaid and QHP populations due to provider payment differentials resulting in annual differences between Obese and Normal Weight individuals of $225[a] and $166[b] for Medicaid and QHPs, respectively.

Medicaid and QHP enrollees were estimated from enrollment at a single point in time from the state's APCD resulting in an enrollment estimate of 32,530 on Medicaid Aid Category 20 and 42,220 on Medicaid premium assistance in QHPs for 25- to 29-year-olds. An obesity rate of 40% for Arkansans aged 26-44 was employed,[13] resulting in an estimated 16,888 Obese enrollees in Medicaid Aid Category 20 and 13,012 Obese enrollees in QHPs.

The total annual excess cost due to obesity among 25- to 29-years-old was estimated to be $3,806,805 for Medicaid Aid Category 20 and $2,158,773 for QHPs.

DISCUSSION

Examination of costs to Medicaid, both during childhood and extending into young adulthood, exposes the policy and economic challenges facing efforts to combat obesity. Clear healthcare cost differentials exist between Obese and Normal Weight children, particularly in early childhood. These differences (increasing to approximately $300 per year for the most severe obesity class) are likely attributable to a higher incidence of select clinical (mostly chronic) comorbid conditions leading to increased healthcare utilization and associated costs.

By early adulthood, conditions continue to lead to higher costs in individuals identified as Obese in childhood (obesity assessments from their last school BMI measurements) but the cost differentials are unlikely to warrant systemic interventions. It is likely that as the cohort ages and as both the frequency and the severity of obesity-related conditions intensify, the cost differential will continue to grow. Assessments of state and public school employees suggest an approximate 24% cost differential for Obese versus Normal Weight employees.[1]

The magnitude of the obesity risk across the population, combined with the differentials in costs, warrants consideration of efforts such as Healthy Active Arkansas to address the epidemic through community-based strategies. Tracking a cohort of Obese individuals over

[a] The estimated annual mean costs were $732, $842, and $958, for Normal, Overweight, and Obese classes, respectively.
[b] The estimated annual mean costs were $2,229, $2,355, and $2,395, for Normal, Overweight, and Obese classes, respectively.

time and documenting the differential and growing costs attributed to obesity-related conditions may heighten awareness, garner continued dissemination of prevention strategies, and justify clinical interventions to ameliorate lifetime health risks and associated state expenditures. Commercially covered individuals would likely have similar profiles.

Finally, the early onset of obesity in childhood and the cumulative effects on both health and associated expenditures warrant intense early childhood education and family interventions to avoid obesity by Kindergarten and the associated health risks that may last a lifetime.

Section 4: Advances in Understanding, New Findings, Policy Implications, and Next Steps Emanating from this Report

ADVANCES IN UNDERSTANDING

This report compiles data and information from 13 years of public school BMI measurements linked with Arkansas Medicaid claims data and the All-Payer Claims Database to examine several items of interest to policymakers, clinicians, and researchers:

1. Weight classification in Kindergarten to determine the proportion of children who are already obese before they start school;
2. Weight classification in each of the measured grades (K, 2, 4, 6, 8) to determine how weight classifications change as children age;
3. Cost of care that may be attributed to obesity in school children;
4. Cost of care that may be attributed to obesity among young adults for whom weight classification was known in school; and
5. Conditions previously described to be associated with obesity and those newly determined are characterized.

NEW FINDINGS

1. Almost 16% of children are obese by Kindergarten with another 16% overweight, compared to 22.2% and 17.2%, respectively, for all school-aged children. This strongly suggests that early childhood should be the important target for interventions.
2. Children entering Kindergarten in higher Obese classifications have an increasing likelihood of remaining obese by Grade 8. Notable, 67.6%, 89.6%, and 96.6% of children in the Obese I, II, and III classes, respectively, remained obese in Grade 8.
3. Building on previous studies, new medical conditions, including myopia, bipolar disorder, eustachian tube disorders/otitis media, and lower limb injuries were observed that affect a disproportionate number of obese children covered by Arkansas Medicaid. In the case of myopia, the association between obesity and this condition has not previously been reported in scientific literature.

4. Compared to normal weight children, obese children not only have extra healthcare costs for Arkansas Medicaid during their childhood, they also generate increased costs to Medicaid in young adults.

POLICY IMPLICATIONS

1. Due to the high proportion of children who are already obese when they enter school, a strong emphasis on prevention should be directed toward preschool children and their families, including during the prenatal period where strong correlates of risk for child obesity have been demonstrated. Many potential initiatives currently align with existing DHS programs and with the goals of Healthy Active Arkansas. The following are examples of such programs:
    - Education and support of obstetric providers to prevent excessive weight gain among pregnant women;
    - Promotion of best practices in breastfeeding, including prenatal education, support for baby-friendly hospitals, and public and worksite nursing station promotion;
    - Appropriate modifications to USDA WIC and SNAP programs, including an emphasis on early childhood nutrition through the Cooperative Extension SNAP education program (e.g., Rethink Your Drink);
    - Incorporation of targeted educational modules addressing sugar-sweetened beverages in the Best Care curriculum for childcare workers; and
    - Acceleration of efforts to increase the availability of local produce through the Arkansas Department of Agriculture (e.g., Farm to School Program).
2. To reverse the obesity risk present at school entry and to protect children from increasing risk, increased emphasis on evidence-based nutrition and physical activity programs in elementary and secondary school need to be broadly standardized and pursued. Current Healthy Active Arkansas projects such as improving access to drinking water and healthier food options in schools are a foundation to build upon. Spreading these initiatives to include community environments such as public parks should be supported.
3. Parental and family engagement to combat the childhood obesity epidemic is necessary. An emphasis on actions parents can take to promote healthy weight among preschool and school-age children is warranted to optimize their future health, academic achievement, and productivity. To this end, a broad-based reinforcing education and communication strategy with targeted consistent and actionable messages will be needed to raise awareness and empower parents to protect their children's health and well-being. Targeted stakeholders of these efforts should include healthcare providers, early childhood education centers, food and nutrition sources, parenting and faith-based centers, and mass media.

4. Growing evidence supports that the cumulative effect of adverse experiences during childhood has long-term health impacts that include obesity and its associated conditions. Described as adverse childhood events (ACES), these include food insecurity and trauma as precipitating contributors to childhood obesity. These may frequently be associated with multi-generational experiences. Specific actions to better characterize and respond to these exposures are necessary to safeguard children from long-lasting impacts.
5. Strategic targeting of obesity-prevention efforts in early childhood (pre-Kindergarten) may help Medicaid avoid compounding costs as children enter the school system and subsequently grow into adults. Quantification of lifetime costs associated with obesity is warranted and would help inform policy decisions.
6. Conditions not previously known to be associated with obesity that are described in this report should be investigated for broader clinical and policy implications.

NEXT STEPS

Obesity and the conditions associated with it continue to represent a major threat to health and a main driver of costs in the U.S. healthcare system. Arkansas has been recognized as a leader in quantitative assessment and programmatic implementation to address this risk. Building on knowledge emanating from this report, there are several clear next steps:

1. Examination of obesity risk by small area analyses across the state could enable and guide targeted programmatic resource allocation to address “hotspots” generating obesity risk in children;
2. Familial analyses through the linkage of information on children covered by Medicaid with parents/caregivers in the same household receiving healthcare coverage through Arkansas Works could help better understand the multi-generational aspects of the obesity threat and offer potential family interventions to ameliorate risk; and
3. Use of microsimulation techniques to assess the lifetime impact of childhood obesity (e.g., costs) as obese individuals age, estimate the cost-benefits of investment in policies to improve rates of obesity and physical inactivity, and project the return on investment of productivity gains from an Arkansas population with lower obesity rates.

Appendix

KINDERGARTEN-TO-GRADE-8 WEIGHT TRANSITION BY RACE

Tables 4A–4D contain Kindergarten to Grade 8 weight status transitions for students stratified by race.

TABLE 4A. KINDERGARTEN-TO-GRADE-8 TRANSITION PROBABILITY (%): ALL RACE

First Assessment		Last Assessment: Grade 8						
		Underweight	Normal Weight	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade K	Underweight	21.7	70.9	4.1	2.2	0.8	0.3	368
	Normal	1.7	72.4	16.4	7.8	1.6	0.2	12,390
	Overweight	0.1	33.4	29.9	26.8	8.3	1.5	3,317
	Obese Class I	0.0	11.1	21.4	34.3	24.4	8.9	2,206
	Obese Class II	0.5	4.1	5.8	23.0	33.6	32.9	583
	Obese Class III	0.0	1.7	1.7	8.4	27.3	60.9	238
	Total	296	10,606	3,545	2,777	1,274	604	19,102

TABLE 4B. KINDERGARTEN-TO-GRADE-8 TRANSITION PROBABILITY (%): WHITE

First Assessment		Last Assessment: Grade 8						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade K	Underweight	27.8	65.0	3.6	2.7	0.5	0.5	223
	Normal	1.8	73.0	15.7	7.9	1.5	0.1	8,412
	Overweight	0.1	34.7	30.5	25.8	7.5	1.4	2,112
	Obese Class I	0.0	11.5	21.7	34.4	24.3	8.1	1,362
	Obese Class II	0.9	4.1	4.7	25.2	33.0	32.1	318
	Obese Class III	0.0	1.6	2.5	6.6	29.5	59.8	122
	Total	221	7,185	2,290	1,767	758	328	12,549

TABLE 4C. KINDERGARTEN-TO-GRADE-8 TRANSITION PROBABILITY (%): BLACK

First Assessment		Last Assessment: Grade 8						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade K	Underweight	11.4	81.9	4.8	1.0	1.0	0.0	105
	Normal	1.5	71.7	17.1	7.2	2.1	0.3	2,655
	Overweight	0.0	30.8	28.0	29.0	10.6	1.8	787
	Obese Class I	0.0	9.4	19.1	33.6	25.0	13.0	524
	Obese Class II	0.0	3.9	7.1	15.4	31.4	42.3	156
	Obese Class III	0.0	1.5	1.5	7.3	20.3	69.6	69
	Total	51	2,288	792	626	334	205	4,296

TABLE 4D. KINDERGARTEN-TO-GRADE-8 TRANSITION PROBABILITY (%): HISPANIC

First Assessment		Last Assessment: Grade 8						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade K	Underweight	18.5	70.4	3.7	3.7	3.7	0.0	27
	Normal	1.4	67.3	20.9	9.3	1.1	0.0	917
	Overweight	0.0	32.4	29.0	29.9	8.0	0.6	324
	Obese Class I	0.0	11.3	23.8	36.6	23.0	5.3	265
	Obese Class II	0.0	4.4	8.8	24.2	39.6	23.1	91
	Obese Class III	0.0	2.7	0.0	18.9	32.4	46.0	37
	Total	18	776	358	309	146	54	1,661

GRADE-TO-GRADE WEIGHT TRANSITION

Tables 5A–5D contain the grade-to-grade transitions of weight status for students of all races. As would be expected from the reviewing content of Figure 1, we see a strong upward trajectory of children in the Underweight category. Furthermore, the most fluctuation can be observed in the Overweight category.

TABLE 5A. KINDERGARTEN-TO-GRADE-2 TRANSITION PROBABILITY (%)

First Assessment		Last Assessment: Grade 2						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade K	Underweight	36.6	59.6	2.1	1.1	0.4	0.1	1,138
	Normal	1.6	84.4	11.0	2.7	0.2	0.0	37,520
	Overweight	0.2	31.6	41.3	25.6	1.3	0.1	9,840
	Obese Class I	0.2	5.4	16.0	55.9	21.4	1.1	6,659
	Obese Class II	0.3	3.0	1.9	15.3	59.3	20.3	1,849
	Obese Class III	0.0	1.7	2.0	1.6	15.2	79.6	706
	Total	1,059	35,890	9,327	7,546	2,856	1,034	57,712

TABLE 5B. GRADE-2-TO-GRADE-4 TRANSITION PROBABILITY (%)

First Assessment		Last Assessment: Grade 4						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade 2	Underweight	48.4	48.0	1.8	1.8	0.1	0.0	968
	Normal	1.9	84.0	12.2	1.9	0.1	0.0	35,799
	Overweight	0.1	19.8	49.8	29.1	1.1	0.1	9,225
	Obese Class I	0.1	2.5	13.1	65.5	18.0	0.8	7,148
	Obese Class II	0.1	1.1	1.2	18.5	63.1	16.0	2,758
	Obese Class III	0.1	1.5	0.6	1.8	18.0	78.0	1,041
	Total	1,150	32,575	9,949	8,577	3,355	1,333	56,939

TABLE 5C. GRADE-4-TO-GRADE-6 TRANSITION PROBABILITY (%)

First Assessment		Last Assessment: Grade 6						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade 4	Underweight	53.4	44.1	1.4	0.6	0.2	0.3	1,091
	Normal	1.9	85.9	10.8	1.3	0.1	0.1	31,633
	Overweight	0.0	22.7	53.6	22.7	0.8	0.1	9,415
	Obese Class I	0.0	3.2	18.1	63.7	14.3	0.6	8,119
	Obese Class II	0.1	1.5	1.5	23.1	60.4	13.5	3,193
	Obese Class III	0.0	1.1	0.6	1.7	19.6	77.1	1,242
	Total	1,196	30,105	9,994	8,477	3,452	1,469	54,693

TABLE 5D. GRADE-6-TO-GRADE-8 TRANSITION PROBABILITY (%)

First Assessment		Last Assessment: Grade 8						
		Underweight	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III	Total
Grade 6	Underweight	47.9	50.8	0.7	0.5	0.2	0.0	1,095
	Normal	1.2	88.5	8.9	1.2	0.1	0.0	28,714
	Overweight	0.1	29.0	51.1	19.0	0.8	0.1	9,455
	Obese Class I	0.0	5.6	21.6	56.1	16.0	0.9	7,927
	Obese Class II	0.1	1.3	3.6	24.1	55.4	15.6	3,194
	Obese Class III	0.0	1.2	0.7	4.0	18.9	75.2	1,304
	Total	763	29,479	9,472	7,329	3,144	1,502	51,689

References

[1] Motley, M. & Whittington, I. (April 10, 2018). *HRA Update*. ACHI slides presented at the State and Public School Life and Health Insurance Board Quality of Care Sub-Committee Meeting, Little Rock, AR. Retrieved from: https://www.dfa.arkansas.gov/images/uploads/ebdOffice/QOC201804.pdf

[2] Study of U.S. High School Students (2017). (n.d.). Retrieved from: https://www.stateofobesity.org/high-school-obesity/

[3] Wang, Y.C., Pamplin, J., Long, M.W., Ward, Z.J., Gortmaker, S.L. & Andreyeva, T. (2015). Severe Obesity In Adults Cost State Medicaid Programs Nearly $8 Billion in 2013. Health Aff (Millwood), 34(11), pp. 1923-1931. doi:10.1377/hlthaff.2015.0633

[4] Streiner, D. & Norman, G. (2009). *Pretty Darned Quick Epidemiology*. Shelton, Conn. People's Medical Publishing House.

[5] Skinner, A.C., Perrin, E.M., Moss, L.A. & Skelton, J.A. (2015). Cardiometabolic Risks and Severity of Obesity in Children and Young Adults. *N Engl J Med, 2015(373)*, pp. 1307-1317. doi:10.1056/NEJMoa1502821

[6] Sidell, D., Shapiro, N. L. & Bhattacharyya, N. (2013). Obesity and the risk of chronic rhinosinusitis, allergic rhinitis, and acute otitis media in school-age children. *Laryngoscope, 123(10)*, pp. 2360-2363. doi:10.1002/lary.24038

[7] Kuhle, S., Kirk, S.F., Ohinmaa, A., Urschitz, M.S. & Veugelers, P.J. (2012). Childhood obesity and otitis media. *Pediatric Obesity, 7(2)*, pp. 151-157. doi:10.1111/j.2047-6310.2011.00011.x

[8] Kim, J.B., Park, D.C., Cha, C.I. & Yeo, S.G. (2007). Relationship between pediatric obesity and otitis media with effusion. *Arch Otolaryngol Head Neck Surg, 133(4)*, pp. 379–382. doi:10.1001/archotol.133.4.379

[9] Goldstein, B.I., Birmaher, B., Axelson, D.A., Goldstein, T.R., Esposito-Smythers, C., Strober, M.A., et al. (2008). Preliminary findings regarding overweight and obesity in pediatric bipolar disorder. *J Clin Psychiatry, 69(12)*, pp. 1953-1959. doi:10.4088/JCP.v69n1215

[10] Jerrell, J.M., McIntyre, R.S. & Tripathi, A. (2010). A cohort study of the prevalence and impact of comorbid medical conditions in pediatric bipolar disorder. *J Clin Psychiatry, 71(11)*, pp. 1518-1525. doi:10.4088/JCP.09m05585ora

[11] Zonfrillo, M.R., Seiden, J.A., House, E.M., Shapiro, E.D., Dubrow, R., Baker, M.D., et al. (2008). The association of overweight and ankle injuries in children. *Ambul Pediatr, 8(1)*, pp. 66-69. doi:10.1016/j.ambp.2007.08.003

[12] Kessler, J., Koebnick, C., Smith, N. & Adams, A. (2013). Childhood obesity is associated with increased risk of most lower extremity fractures. Clin Orthop Relat Res, 471(4), pp. 1199-1207. doi:10.1007/s11999-012-2621-z

[13] The State of Obesity in Arkansas. (n.d.). Retrieved from: https://www.stateofobesity.org/states/ar/