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The Burden of Obesity, Elevated Blood Pressure, and Diabetes in Uninsured and Underinsured Adolescents

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Abstract

Background: Obesity, elevated blood pressure (BP), and diabetes mellitus are rising among the general U.S. adolescent population, but prevalence estimates are not available for uninsured or Medicaid populations.
Methods: This retrospective epidemiological study extracted 155,139 electronic medical records collected between 1998 and 2012 on patients aged 10–19 years, from a clinical population predominantly uninsured or insured by Medicaid. Age, sex, race, height, weight, BP, and insurance type were captured at first clinic visit. Classifications included obesity (≥95th body mass index percentile), elevated BP (≥90th percentile), and diabetes mellitus (ICD-9-250.xx).
Results: Among the 26,696 patients with complete data at first clinic visit, 24.4% were classified as obese and 39.5% had elevated BP. In logistic regression analyses, odds of obesity were significantly higher among uninsured versus commercially insured patients (odds ratio [OR]: 1.1 [95% confidence interval: 1.0–1.2]) and girls (OR: 1.3 [1.2–1.4]), but lower among older adolescents (for 15–17 years, OR: 0.7 [0.6–0.7]; for 18–19 years, OR: 0.7 [0.7–0.8]). Odds of elevated BP were significantly higher among Medicaid (OR: 1.1 [1.0–1.2]) and uninsured (OR: 1.2 [1.1–1.4]) versus commercially insured patients, but lower among African American versus White youth (OR: 0.9 [0.8–0.9]). Prevalence of type 1 diabetes was 1.46 per 1000 and prevalence of type 2 diabetes was 1.68 per 1000, with both occurring more often in girls versus boys and in Whites versus African Americans.
Conclusion: In this low-income clinical population, prevalence of obesity and elevated BP were higher than national estimates. The provision of preventive healthcare to all Medicaid and uninsured youth should remain a priority.

Keywords: hypertension, type 2 diabetes mellitus, overweight, pediatrics, prevalence, electronic medical record

Introduction

Obesity increased in U.S. adolescents from 1999 to 2014, with an estimated 20.5% of 12- to 19-year-old adolescents now classified as obese.[1] As obesity prevalence has risen, so too have associated comorbidities: 16.3% of adolescents have elevated blood pressure (BP) and 19.2% have poor or intermediate fasting blood glucose levels.[2] Furthermore, cases of diabetes increased by one-third among youth aged 10–19 years over the past decade.[3] However, national estimates of obesity and comorbidities are based on samples for which the majority of adolescents report an annual household income above the U.S. Census median[2,3] and are covered by commercial health insurance.[3]

Health insurance is a direct driver of healthcare access for preventive and chronic care. An estimated 47.9 million nonelderly U.S. citizens are uninsured, of whom 90% live below 400% of the poverty line and 38% live below the poverty line.[4] One-fifth of Louisiana nonelderly citizens are uninsured, ranking Louisiana among the highest states in this regard.[4] Based on the U.S. National Health Interview Survey, half of uninsured patients reported no usual source of medical care and 30% reported postponing seeking care due to cost.[4]

People living in the Southern United States, including the state of Louisiana, face limited access to medical care due to financial cost and low levels of physicians per capita.[5] Government-funded insurance coverage, that is, Medicaid, has substantially increased for adolescents over the prior decade with a decline in adolescents who are uninsured or on commercial coverage.[5] However, adolescents receiving Medicaid coverage have a higher prevalence of obesity[6] and are less likely to receive regular healthcare visits compared to their peers who are funded by commercial insurance.[5]

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The objective of this study was to describe demographic and health characteristics of youth who were uninsured or insured by Medicaid compared to those on commercial insurance and examine the prevalence of obesity and elevated BP, and the diagnosis of diabetes in this low-income clinical population.

Materials and Methods

Electronic medical records were extracted from a database operated by the Louisiana State University Health Care Services Division (LSUHCSD), including administrative, anthropometric, laboratory, and clinical diagnosis data from seven public hospitals and affiliated clinics in Louisiana. The secondary data analysis of deidentified data was approved by the Pennington Biomedical Research Center Institutional Review Board.

As described previously,[7] the overall pediatric and adult population that was served by LSUHCSD consists of 46% of patients who qualified for free care (due to being uninsured and at or below 200% of federal poverty level), 34% who were covered by Medicare or Medicaid, 10% who were self-pay (uninsured, but incomes not low enough to qualify for free care), and 10% covered by commercial insurance. This analysis extracted records of patients from the years 1998 to 2012 who were between the ages of 10 and 19 years at first visit to the LSUHCSD hospital or clinic. To establish demographics of the overall sample, the first clinic visit for each patient was extracted. Patients who were missing information on date of birth, sex, or race were excluded, leaving an analytic sample of $n = 155{,}139$. Age was calculated based on date of birth and first clinic visit date. Race was coded as African American, White, or Other.

Obesity and BP sample

To establish prevalence of obesity and elevated BP, an obesity and BP sample was created that consisted of the first clinic visit for each patient that included insurance type and height, weight, and BP measurements. There were 26,696 unique patients with complete data.

Body mass index (BMI) z-scores and percentiles were calculated using the 2000 Centers for Disease Control and Prevention (CDC) Growth Charts for the United States based on the child's age, sex, height, and weight.[8] BMI was categorized as underweight (<5th percentile), normal weight (5th to <85th percentile), overweight (85th to <95th percentile), or obese (≥95th percentile). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were converted to percentiles based on age, sex, and height.[9] BP was classified as elevated if either SBP or DBP were ≥90th percentile.[9] Outliers for BMI z-score (< −4 or >5), height-for-age z-score (< −5 or >3), and weight-for-age z-score (< −5 or >5), and two outliers for SBP (>300 mmHg) were removed from the analysis.

Compared to the overall sample ($n = 155{,}139$), the subsample ($n = 26{,}696$) was younger (15.0 vs. 15.3 years, $P < 0.0001$), had a lower proportion of African Americans (57.7% vs. 62.9%, $P < 0.0001$), and had a higher proportion of girls (58.8% vs. 51.7%, $P < 0.0001$).

Diabetes sample

To establish prevalence of diabetes, a diabetes sample was created that consisted of case patients who were diagnosed with diabetes before the age of 20 years ($n = 488$) according to the *Ninth Revision of the International Classification of Diseases* (ICD-9-250.xx) billing codes based on physician diagnosis (for type 1 diabetes, 250.01, 250.03, 250.11, 250.13, 250.51, 250.81, and 250.91; for type 2 diabetes, 250.00, 250.02, 250.10, 250.12, 250.20, 250.50, 250.60, 250.80, and 250.90). The ICD-9 codes for diagnoses have been validated in the LSUHCSD database against the American Diabetes Association criteria with 97% agreement.[10]

Statistical analyses

Means and frequencies were calculated for each sample. Logistic regression analysis was used in the obesity and BP sample to estimate the odds of obesity with the independent variables of insurance (uninsured and Medicaid vs. commercial), age group (15–17 and 18–19 years vs. 10–14 years of age), sex, and race (African American and Other vs. White). Separate logistic regression analyses were conducted with elevated BP as the dependent variable. Statistical significance was accepted at alpha <0.05. Prevalence of diabetes was calculated based on the number of prevalent cases divided by the total population of pediatric patients and stratified by age group, sex, and race.

Results

The general pediatric population was on average 15.3 ± 2.7 years of age and 51.7% were girls. The race distribution included 57.7% African American, 33.7% White, and 4.4% other. Insurance coverage included 53.2% on Medicaid, 36.8% uninsured, 8.7% on commercial insurance, and 1.3% missing insurance type.

Obesity prevalence and demographic correlates

Among the subset of children with available insurance, BMI, and BP data, 24.4% were obese and 17.9% were overweight (Table 1). In the logistic regression model, girls and adolescents who were uninsured had a greater likelihood of being obese, whereas older adolescents had a lower likelihood of being obese (Table 2). Although 39.5% of children had elevated BP, the proportion was higher specifically among overweight (42.4%) and obese (58.0%) youth. Odds of elevated BP were higher for adolescents who were uninsured or on Medicaid (vs. commercial), but lower for African American and Other race groups compared to White youth. Compared to adolescents aged 10–14 years, odds of elevated BP were higher for those aged 18–19 years, but lower for those aged 15–17 years.

Diabetes prevalence and demographic correlates

Based on 250.xx ICD-9 code, there were 488 cases of diabetes, including 46.5% classified as type 1 diabetes and 53.5% classified as type 2 diabetes (Table 3). Prevalence was slightly higher for type 2 diabetes versus type 1 diabetes (1.68/1000 vs. 1.46/1000, respectively). Prevalence of both type 1 and type 2 diabetes was higher for girls compared to boys and for Whites compared to the African American and Other race groups. Type 1 diabetes was more commonly diagnosed at a younger age, whereas type 2 diabetes was more commonly diagnosed in the older age groups.

Table 1. Descriptive Characteristics of Children in the Obesity and Blood Pressure Sample

	African American		*White*		*Other*		
	Boys	*Girls*	*Boys*	*Girls*	*Boys*	*Girls*	*Total*
No. of patients	7069	9481	3904	5071	489	682	26,696
Age, years	16.5 ± 2.6	16.9 ± 2.5	16.5 ± 2.7	16.8 ± 2.5	16.2 ± 2.5	16.7 ± 2.3	16.7 ± 2.5
Insurance type							
Commercial	9.0	8.2	13.2	13.4	9.4	8.2	10.2
Medicaid	64.2	65.6	46.3	46.4	36.6	47.4	57.8
Uninsured	26.8	26.2	40.4	40.3	54.0	44.4	32.1
BMI z-score	0.6 ± 1.2	0.7 ± 1.2	0.6 ± 1.3	0.7 ± 69.3	0.7 ± 1.2	0.8 ± 72.2	0.7 ± 1.2
BMI percentile	64.5 ± 29.9	73.0 ± 27.5	65.4 ± 31.6	69.3 ± 29.4	67.5 ± 30.5	72.2 ± 26.6	68.8 ± 29.4
Underweight, %	3.4	2.2	4.1	3.1	3.9	1.6	3.0
Normal weight, %	62.6	49.2	56.5	52.6	53.4	54.7	54.7
Overweight, %	14.3	20.8	14.4	20.1	17.2	20.8	17.9
Obese, %	19.8	27.8	25.1	24.2	25.6	22.9	24.4
Blood pressure							
SBP, mmHg	125.0 ± 16.0	119.3 ± 14.7	126.8 ± 16.2	120.3 ± 14.3	125.2 ± 16.3	117.2 ± 14.7	122.2 ± 15.5
SBP, percentile	68.2 ± 29.7	68.7 ± 29.0	72.3 ± 28.2	71.9 ± 27.6	71.7 ± 27.9	65.4 ± 30.2	69.6 ± 28.9
DBP, mmHg	69.3 ± 11.1	69.2 ± 10.5	68.9 ± 10.8	67.8 ± 10.5	69.9 ± 11.3	67.7 ± 10.6	68.9 ± 10.7
DBP, percentile	54.0 ± 27.2	26.7 ± 0.0	52.9 ± 27.0	57.1 ± 27.1	58.4 ± 26.3	56.9 ± 27.3	56.7 ± 27.1
Elevated BP, %	37.6	39.1	41.9	41.4	41.7	35.9	39.5

Proportions may not equal 100% due to rounding.
BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.

Discussion

Prevalence of obesity and elevated BP among this Louisiana adolescent cohort was higher than national estimates. Forty-two percent were classified as overweight or obese, compared to 35% of boys and 33% of girls in a nationally representative sample of U.S. adolescents aged 12–19 years.[2] Furthermore, 4 in 10 adolescents in the Louisiana cohort had elevated BP versus 1 in 10 in the nationally representative sample.[2] A probable reason for these differences is that the Louisiana cohort represented an uninsured and underinsured population: 32% were uninsured and 58% were on Medicaid. Insurance type predicted both obesity and elevated BP, with adolescents covered by commercial insurance at healthier weight and BP status. Lack of insurance coverage, or limited coverage, reduces access to healthcare, including screening, preventive, and treatment services.[6,11] Limited healthcare access, in turn, is related to food insecurity in adolescents.[12]

Table 2. Logistic Regression Analysis Predicting Odds of Obesity and Elevated Blood Pressure

	Obesity		*Elevated blood pressure*	
	OR	*95% CI*	*OR*	*95% CI*
Insurance type				
Commercial	Ref.		Ref.	
Medicaid	1.0	1.0–1.2	1.1*	1.0–1.2
Uninsured	1.1*	1.0–1.2	1.2***	1.1–1.4
Age, years				
10–14	Ref.		Ref.	
15–17	0.7***	0.6–0.7	0.9***	0.8–1.0
18–19	0.7***	0.7–0.8	1.1**	1.0–1.2
Sex				
Boy	Ref.		Ref.	
Girl	1.3***	1.2–1.4	1.0	1.0–1.1
Race				
White	Ref.		Ref.	
African American	1.0	0.9–1.1	0.9***	0.8–0.9
Other	1.0	0.8–1.1	0.9*	0.8–1.0

***$P < 0.001$, **$P < 0.01$, *$P < 0.05$.
CI, confidence interval; OR, odds ratio.

Furthermore, behaviors associated with obesity are more prevalent among adolescents at the lower end of the socioeconomic spectrum, including high levels of screen time.[5] Adolescents from low socioeconomic households tend to live in neighborhoods with low access to physical activity facilities, which is associated with low levels of physical activity and high prevalence of obesity.[11]

Prevalence of type 1 diabetes in this Louisiana cohort (1.46/1000) was lower than other cohorts, including the U.S. National Health and Nutrition Examination Survey (NHANES) (3.8/1000 for youth aged 12–19 years)[13] and the SEARCH for Diabetes in Youth Study (2.69/1000 for youth aged 10–14 years and 3.22/1000 for youth aged 15–19 years).[3] By contrast, the prevalence of type 2 diabetes in this Louisiana cohort (1.68/1000) was similar to the NHANES cohort (1.8/1000),[13] and both were higher than the SEARCH cohort (0.46/1000).[3]

There are limited population-based prevalence estimates of pediatric diabetes in the United States, and there are important distinctions among the datasets that may explain the observed differences in prevalence across cohorts. First, there may be a higher burden of obesity-related type 2 diabetes in the Louisiana cohort, which was largely composed of underinsured and uninsured adolescents in a highly impoverished state, compared to the SEARCH cohort, which was compiled from EMR data collected from a commercial health plan in four geographic areas and one managed healthcare plan. NHANES provided data on a nationally representative cross-section of the United States, although not a clinical population. The present prevalence estimates offer new data by providing clinical data from a state in the southern region of the United

Table 3. Prevalence of Diabetes by Demographic Characteristics

	No. of Youth		
	Cases with diabetes	General population	Prevalence per 1000
Type 1 diabetes			
Total	227	155,139	1.46
Age, years			
10–14	98	65,740	1.49
15–17	93	61,716	1.51
18–19	36	27,683	1.30
Sex			
Girls	123	81,386	1.51
Boys	104	73,753	1.41
Race			
African American	135	96,767	1.40
White	82	51,881	1.58
Other	10	6490	1.54
Type 2 diabetes			
Total	261	155,139	1.68
Age, years			
10–14	67	65,740	1.02
15–17	120	61,716	1.94
18–19	74	27,683	2.67
Sex			
Girls	156	81,386	1.91
Boys	105	73,753	1.42
Race			
African American	158	96,767	1.63
White	97	51,881	1.87
Other	6	6490	0.92

States and by focusing specifically on uninsured youth and those insured by Medicaid.

Second, the SEARCH Study validated diabetes cases with physician reports and medical chart reviews that were followed up with clinic visits to distinguish diabetes type based on antibodies and fasting C-peptide levels.[14] The NHANES cohort captured both diagnosed diabetes (5.6/1000 adolescents) based on self-report of physician diagnosis or use of insulin or oral diabetic pills and undiagnosed diabetes (2.8/1000 adolescents) based on fasting blood glucose ≥126 mg/day among participants who did not self-report diabetes.[13] By contrast, in this cohort, diabetes cases were identified by ICD-9 code only, but it is not known if a physician ordered a fasting glucose or oral glucose tolerance test. Therefore, the type of diabetes may have been misclassified, and there were likely missed cases of asymptomatic diabetes.

Undiagnosed diabetes is estimated to account for one-third of type 2 diabetes cases in adolescents, with African American youth having twice as many cases of undiagnosed diabetes compared to White youth.[13] It may be that the diagnosis of diabetes was lower in the uninsured and Medicaid population, but undiagnosed asymptomatic diabetes may be equivalent or higher. Third, the SEARCH prevalence data were collected in the year 2009, whereas the NHANES (1999–2010) and Louisiana (1998–2012) were collected over a number of years. Examining the trajectory of change in diabetes diagnosis is an important area for future research.

Not surprisingly, odds of elevated BP and prevalence of diabetes were highest among the older adolescents aged 18–19 years. However, the older youth had a lower prevalence of obesity. Obesity screening and preventive services should begin at an early age to improve behavioral patterns and avoid comorbidities that may be harder to reverse as the adolescent ages.[15]

In this Louisiana cohort, girls had higher odds of being obese, similar levels of elevated BP, and a higher prevalence of diabetes than boys (3.43/1000 vs. 2.83/1000 in boys). In contrast, national estimates observed substantially higher prevalence of elevated BP in boys[2] and similar prevalence of obesity[1] and diabetes[3] between the sex groups. African American girls appeared to drive the sex differences, with obesity prevalence 8% points higher than African American boys. African American adolescent girls consistently have the highest prevalence of obesity among demographic groups at a national level and also tend to have lower levels of physical activity and a less healthy diet than White youth or African American boys.[16]

Interestingly, when girls and boys were combined, African Americans had similar prevalence of obesity and diabetes as Whites, and African Americans were less likely to have elevated BP compared to Whites. These estimates align with a prior study of the adults from the LSUHSCD database, which found that the prevalence of coronary heart disease, heart failure, and stroke was higher among Whites with diabetes than their African American counterparts.[17]

In contrast, the lack of health disparities is in stark contrast with national estimates, which estimate that African American youth have a higher prevalence of obesity[16] and elevated BP[2] and a six-fold higher prevalence of type 2 diabetes, although a lower prevalence of type 1 diabetes, compared to White youth.[3] Obesity prevalence is inversely related to household income in White youth aged 2–19 years, whereas there is no significant association in African American youth.[18] Eighty percent of the White youth in this Louisiana cohort were uninsured or on Medicaid, to a certain extent removing the confounding healthcare access and socioeconomic status differences that often drive race differences between White and African American groups. Screening and preventive services should focus on all high-risk youth at the lower end of the socioeconomic spectrum, regardless of race or ethnicity.

Strengths of this study included the large database of clinical records representing adolescents of low socioeconomic households and the representation of both sex groups and of African American and White youth. There are several limitations to this secondary data analysis, chiefly the reliance on data entered for billing purposes and not for research purposes. Because of this, it was not possible with the dataset to independently verify diabetes diagnosis or validate diabetes subtype such as with laboratory data (*e.g.*, antibodies and C-peptide levels) or longitudinal treatment data. BP was from a single measurement in clinic; therefore, the prevalence of high BP may be overestimated due to the lack of confirmatory readings.

There was no direct measure of socioeconomic status, although insurance type was used as a proxy for household income. Diabetes was classified according to ICD-9 code, so there may be missed cases of asymptomatic diabetes. However, ICD-9-250.xx billing codes have been indicated as the best single criterion to ascertain pediatric diabetes cases, compared to laboratory test results and diabetes-related medications.[19] In a study of the EMR data collected on 57,767 children aged <20 years in the SEARCH for Diabetes in Youth Study, the ICD-9 code had a 97% sensitivity and 82.2% positive predictive value to correctly classify diabetes.[19] Finally, an analysis of diabetes diagnosis by BMI classification was not possible due to limited height and weight data recorded at the diagnosis clinic visit.

In conclusion, compared to national estimates, prevalence of obesity and elevated BP was higher in this Louisiana cohort of adolescents who were uninsured or insured with government assistance. Girls were at particularly high risk for obesity and diabetes, although the previously observed health disparities between African American and White youth were not observed for this low-income clinical population. The screening and prevention of obesity and its related comorbidities should remain a high priority for all youth who are uninsured or insured by Medicaid.

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Author Disclosure Statement

No conflicting financial interests exist.

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