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The Pediatric Obesity Epidemic Continues Unabated in Bogalusa, Louisiana

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Abstract

Objectives—To examine 35-year trends in the prevalence of overweight and obesity among children and adolescents from Bogalusa, LA.

Patients and Methods—Height and weight were measured for 11,653 children and adolescents between 5 and 17 years of age in 8 cross-sectional surveys. The Bogalusa Heart Study contributed data from 1973–1994, and routine school screening provided 2008–2009 data. Trends in mean BMI, mean gender-specific BMI-for-age z-scores, prevalence of overweight/obesity (BMI ≥85th percentile), and prevalence of obesity (BMI ≥95th percentile) by age, race, and gender were examined.

Results—Since 1973–1974, the proportion of children and adolescents aged 5 to 17 years who are overweight (overweight plus obese) has more than tripled, from 14.2% to 48.4% in 2008–2009. Similarly, the proportion of obese children and adolescents has increased more than fivefold from 5.6% in 1973–1974 to 30.8% in 2008–2009. The prevalence of overweight or obesity, and secular changes, were similar across black and white boys and girls.

Conclusions—In semirural Bogalusa, the childhood obesity epidemic has not plateaued, and nearly half of children are now overweight or obese.

Keywords

Overweight; obesity; trends; rural

Introduction

The prevalence of pediatric overweight and obesity has increased substantially in recent decades in the general US population.¹ The Bogalusa Heart Study is a long-term

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community-based investigation of the natural history of cardiovascular disease from childhood into adulthood in a biracial (black-white), semirural Louisiana population.² Given that the Bogalusa Heart Study represents a well characterized bi-racial population of children and youth examined between 1973 and 1994,³ the purpose of this study was to examine temporal trends across the various examination periods of the Bogalusa Heart Study and to extend the observations to 2009. Cross-sectional data collected at eight different time points between 1973 and 2009 were used.

Patients and Methods

Population and Study Sample

Eligible participants were drawn from children and adolescents living in Ward 4 (Bogalusa, LA) of Washington Parish in southeast Louisiana. Over the 35 years described in this study, Bogalusa, LA has undergone demographic shifts, from a community of ~20,000 people (65% white, 35% black) to one of ~13,000 people (57% white, 41% black in the general population; and 45% white, 55% black among children aged <18 years). Within the Bogalusa Heart Study, 7 cross-sectional surveys have been conducted among children and adolescents between 1973 and 1994, and many children have participated in multiple surveys.³ More recent data (2008–2009) were obtained from routine measurements of students from the Bogalusa Middle School (grades 6–8, ages 11–16 years) and Bogalusa High School (grades 9–12, ages 15–20 years), which enroll ~81% of children of these ages who reside in the community.⁴

The analytic sample consists of 23,367 observations from 11,653 children and adolescents between 5 and 17 years of age. The repeated cross-sectional design resulted in a total of 5,294 participants being measured only 1 time, while 2,923 were measured twice, 1,841 were measured 3 times, and 1,595 were measured 4 or more times. All Bogalusa Heart Study protocols were approved by the appropriate Louisiana State University and Tulane University research ethics boards. The Pennington Biomedical Research Center institutional review board approved the analyses for our study.

Anthropometric Assessment

For all Bogalusa Heart Study participants, height and weight were measured twice to the nearest 0.1 cm and 0.1 kg, respectively, using an Iowa height board and a balance-beam scale (Detecto Scales, Inc, Webb City, MO). For Bogalusa High School and Middle School students measured in 2008 and 2009, single measures of height and weight were assessed by student health clinic staff to the nearest 0.25 in and 0.25 lb, respectively, using a stadiometer and a dial step-on scale (Health-O-Meter [Health-O-Meter, Bedford Heights, OH]). BMI was computed as weight in kilograms divided by height in meters squared. The BMI status of the children and gender-specific BMI-for-age *z* scores were computed using the Centers for Disease Control and Prevention growth charts for BMI,⁵ and children were classified as having normal weight (<85th percentile) or being overweight/obese (≥85th percentile) or obese (≥95th percentile).

Statistical Analysis

Survey-specific mean BMI, mean BMI *z* score and prevalence of overweight/obesity and obesity were computed and trends were assessed by using generalized estimating equations (Proc GENMOD [SAS Institute, Inc, Cary, NC]), which account for repeated measurements of study participants. Within the sample, the age distribution varied across surveys, and the proportion of black children increased over time, coinciding with demographic shifts in the Bogalusa population. To account for differences in race, gender, and/or age across surveys, regression models adjusted for these effects, and least-squares means were presented.

Stratified analyses provided age-group-specific prevalence estimates and trends, also adjusted for race and gender differences across surveys. Secular trends in outcomes were estimated using a linear (additive) model for change in risk over time.^{6, 7} Differences in rates of increase in the outcomes among the age or race-gender groups were tested by examining the significance of the group-by-time interaction effect in the regression models. All data management and analyses were conducted using the SAS system and procedures.

Comparison to U.S. Trends

We obtained data from the National Health and Nutrition Examination Survey (NHANES), a series of cross-sectional, nationally-representative surveys conducted by the Centers for Disease Control and Prevention, for the following survey cycles: NHANES I (1971–1975), NHANES II (1976–1980), NHANES III (1988–1994), NHANES 1999–2000, NHANES 2001–2002, NHANES 2003–2004, NHANES 2005–2006, and NHANES 2007–2008. BMI status and overweight/obesity classifications for the children and adolescents within the NHANES samples were calculated according to the methods described above for the Bogalusa sample. For each survey cycle, we limited our analysis to children and adolescents between the ages of 5 and 17, to be consistent with our Bogalusa sample. Overweight/obesity and obesity prevalences and SEs were estimated for each survey cycle using appropriate sample weights and design parameters in SAS Proc SURVEYFREQ.

Results

Table 1 lists the mean BMI and proportions of overweight/obesity and obesity, adjusted for age, race, and gender differences across the survey samples, for the 8 cross-sectional surveys that were conducted (1973–1974, 1976–1977, 1978–1979, 1981–1982, 1984–1985, 1987–1988, 1992–1994, and 2008–2009). Overall, mean BMI increased from 18.2 kg/m² in 1973–1974 to 23.8 kg/m² in 2008–2009, representing an increase of 1.5 BMI units per 10 years in this population. The proportion of children who were overweight/obese increased from 14.2% in 1973–1974 to 48.4% in 2008–2009, whereas the proportion who were obese increased from 5.6% to 30.8% over the same time period. The prevalence of overweight/obesity and obesity increased at a rate of 9.6% and 6.6% per 10 years, respectively. Secular changes in mean BMI, mean BMI z score, overweight/obesity, and obesity were more pronounced in children aged 10 years and older, compared to those in the youngest age group (mean BMI: $p<0.0001$ for differences among age groups; mean BMI z-score: $p<0.0001$; overweight/obesity: $p<0.0001$; obesity: $p<0.0001$).

Figure 1 shows the changes in the proportion of children and adolescents classified as overweight/obese (Fig 1A) and obese (Fig 1B), by race and gender, over the 35-year time period. All race-gender groups have experienced an increase in the prevalence of overweight and obesity, with all groups exhibiting rates of $\geq 44\%$ for overweight/obesity and 25% for obesity in 2008–2009. Secular changes in the prevalence of overweight/obesity and obesity were similar across all race-gender groups (overweight/obesity: $p=0.82$ for differences among groups; obesity: $p=0.40$).

Discussion

These results demonstrate that the prevalence of overweight and obesity among youth has increased dramatically in the semirural town of Bogalusa, LA over the last 35 years, and rates do not appear to be slowing. Since 1973–1974 the proportion of children and adolescents who are overweight (including obese) has more than tripled, from 14.2% to 48.4% in 2008–2009. Similarly, the proportion of obese children and adolescents has increased more than fivefold from 5.6% in 1973–1974 to 30.8% in 2008–2009. These

increases are seen in all age groups, in both girls and boys, and in both white and black youth.

Secular increases in the prevalence of overweight and obesity in US children and adolescents are well documented^{1, 8–11} and are generally consistent with our results. However, the prevalence of overweight and obesity seen in Bogalusa provides evidence that certain communities around the country may already be reaching levels of obesity that were not predicted to occur for another 10 years.¹² The results of this study do not support recent observations based on NHANES data that childhood overweight and obesity prevalences may be plateauing.¹ Compared to national levels of overweight and obesity, children in Bogalusa have experienced higher rates of increase since the early 1980's, and the gap appears to be widening (Fig 2). The different interpretations of the current state of the childhood obesity epidemic given by the Bogalusa trends compared to NHANES-based national trends may be due, in part, to the variability of the NHANES estimates resulting from its relatively small sample size and complex sampling scheme; for example, in 2005–2006, while 16.3% of children aged 5 to 17 years were estimated to be obese, the 95% confidence interval ranged from 13.0% to 19.6%. Alternatively, these results may suggest that, although certain communities may be making strides toward arresting childhood obesity rates, others remain at high risk.

The high levels of obesity seen in Bogalusa have also been seen in other rural communities in Louisiana. The LA Health Study, conducted among 2,709 children aged 8 to 15 years (average age 10.5 years) from 43 schools in rural communities across Louisiana, revealed that, in 2006, 45.1% of its study participants were overweight/obese and 27.4% were obese. Rural areas generally experience higher poverty rates compared to urban areas¹³ and are typically limited in their access to healthy food choices and opportunities for physical activity.^{14,15} Consequently, children from rural areas may be at a particularly high risk of obesity. An analysis of data from the National Survey of Children's Health revealed that nonmetropolitan residence and poverty were both independently associated with increased risk of obesity in children aged 10 to 17 years.¹⁶ Other research has noted increased risk of obesity among children from rural areas compared to children from urban areas, even after adjusting for markers of socioeconomic status.¹⁷

It is important to note that there do not seem to be any systematic differences in the observed secular trends in obesity among the race-gender groups, although black boys had the lowest prevalence of obesity at almost all time points. Recent data from the LA Health Study, conducted in rural Louisiana, also did not find any differences in the prevalence of obesity among black and white boys and girls.¹⁸ The similarities in risk of obesity across racial groups may be a phenomenon particular to rural areas, where environmental factors known to influence dietary and physical activity behaviors are potentially more homogeneous within a community. Although research focused on rural populations is limited, it appears that there may be smaller differences in levels of physical activity across racial groups in rural populations compared to urban ones.¹⁹ Taken together, results suggest that, in rural areas, interventions to address obesogenic social and physical environments may have broad reach across racial groups.

Our study was limited by the lack of data on socioeconomic status and how this may have changed over time. According to US Census data, the percentage of Bogalusa residents living in poverty was relatively stable from 1990 to 2000 (37% in 1990, 33% in 2000); therefore, at least at an ecologic level, the observed trends do not appear to be driven by socioeconomic changes in this population. Furthermore, race and poverty are highly related in Bogalusa (48% of blacks were living in poverty in 2000, compared with 21% of whites), yet we saw no differences in obesity trends and prevalence according to race, which

suggests that in this population, socioeconomic factors likely would not explain the rising obesity trends.

The observations made from these secular trends have serious implications. Elevated BMI has been shown to have marked adverse associations with various risk factors including higher levels of blood pressure, abnormal levels of lipoproteins, and higher insulin levels.²⁰ Also, current childhood obesity rates far exceed the objective set by *Healthy People 2010*²¹ to reduce to 5% the proportion of children and adolescents who are obese, and more than a stabilization of the rates will be needed to meet this or any subsequent goals.

Conclusion

These data provide 35-year trends in overweight/obesity and obesity and highlight the obesity epidemic in the rural South, an area that features some of the highest rates in the United States.¹⁰ In addition, they provide yet another example of the gap between the current status of the childhood obesity epidemic and national goals to reduce childhood obesity. Thirty-five years of data from Bogalusa, LA suggest that the childhood obesity epidemic is not plateauing in this semirural community. Concerted obesity-prevention efforts that intervene at multiple levels of influence²² are needed to slow and, ultimately, to reduce the prevalence of childhood overweight and obesity.

Abbreviations

BMI	body mass index
NHANES	National Health and Nutrition Examination Survey

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Figure 1.
Changes in the proportion of children and adolescents 5 to 17 years of age classified as overweight (BMI $\geq 85^{\text{th}}$ percentile; includes obese) (A) or obese (BMI $\geq 95^{\text{th}}$ percentile) (B) in Bogalusa, LA, 1973–2009.

Figure 2. Bogalusa, LA compared to United States (NHANES): changes in the proportion of children and adolescents 5 to 17 years of age classified as being overweight (BMI $\geq$ 85th percentile; includes obese) (A) or obese (BMI $\geq$ 95th percentile) (B).

Table 1

Changes in the mean BMI, mean BMI z score, and proportions of overweight (BMI ≥ 85th percentile) and obesity (BMI ≥ 95th percentile) among children and adolescents 5 to 17 years of age in Bogalusa, LA, 1973–2009.

Survey Year	No. of children examined	BMI, Mean (SD) ^a	BMI z-score, Mean (SD) ^a	Overweight/Obese, % ^a	Obese, % ^a
Total					
1973–74	3,826	18.2 (3.5)	0.0 (1.1)	14.2	5.6
1976–77	3,954	18.5 (3.1)	0.1 (0.9)	16.3	6.1
1978–79	3,514	18.6 (2.9)	0.1 (0.8)	17.2	6.6
1981–82	3,267	18.8 (3.0)	0.1 (0.8)	17.9	7.3
1984–85	2,499	19.5 (3.1)	0.2 (0.7)	22.3	9.5
1987–88	3,194	19.8 (3.5)	0.3 (0.8)	25.7	11.3
1992–94	3,073	20.8 (4.3)	0.5 (1.0)	31.3	16.4
2008–09	509	23.8 (6.6)	0.9 (1.1)	48.4	30.8
Estimated secular change (per 10 y) ^b	--	1.5	0.3	9.6	6.6
Ages 5–9 y					
1973–74	1,415	16.1 (2.0)	0.1 (0.8)	16.0	6.5
1976–77	1,332	16.4 (2.1)	0.1 (0.8)	17.0	7.4
1978–79	1,260	16.6 (2.4)	0.1 (0.9)	18.5	7.8
1981–82	330	17.9 (2.4)	0.3 (0.7)	25.9	13.1
1984–85	1,255	16.7 (2.9)	0.3 (1.1)	22.4	10.0
1987–88	1,037	17.1 (3.2)	0.4 (1.1)	28.0	13.8
1992–94	0				
Estimated secular change (per 10 y) ^b	--	0.7	0.2	7.8	4.6
Ages 10–14 y					
1973–74	1,917	18.0 (3.3)	−0.1 (0.9)	15.9	6.1
1976–77	1,526	18.8 (3.0)	0.1 (0.8)	18.8	7.1
1978–79	1,470	19.0 (3.1)	0.1 (0.8)	20.3	8.3
1981–82	1,413	19.2 (3.3)	0.1 (0.8)	20.7	9.6
1984–85	1,450	19.9 (3.5)	0.3 (0.8)	25.2	10.7

Survey Year	No. of children examined	BMI, Mean (SD) ^a	BMI z-score, Mean (SD) ^a	Overweight/Obese, % ^a	Obese, % ^a
1987–88	1,341	20.6 (4.0)	0.4 (0.9)	30.1	13.6
1992–94	1,429	20.9 (4.9)	0.5 (1.1)	34.5	18.6
2008–09	317	24.0 (6.5)	1.0 (1.1)	51.1	33.6
Estimated secular change (per 10 y) ^b	--	1.6	0.3	10.1	7.2
Ages 10–14 y					
1973–74	0				
1976–77	1,013	21.2 (3.4)	0.1 (0.9)	16.4	5.7
1978–79	712	21.4 (3.0)	0.0 (0.8)	15.0	5.6
1981–82	594	21.5 (3.6)	0.1 (0.9)	17.2	6.7
1984–85	719	22.3 (4.4)	0.3 (1.0)	23.3	11.4
1987–88	598	23.0 (4.9)	0.4 (1.0)	27.8	12.5
1992–94	607	23.0 (5.1)	0.4 (1.1)	29.8	14.8
2008–09	192	26.1 (6.7)	0.9 (1.1)	48.4	29.1
Estimated secular change (per 10 y) ^b	--	1.5	0.3	10.1	7.1

^a Mean BMI, mean BMI z score and proportions of overweight and obesity were adjusted for any gender, race, or age differences across the survey samples.

^b All changes are statistically significant at $p < .0001$.