Increasing Prevalences of Overweight and Obesity in Northern Plains American Indian Children

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Objectives: To report prevalences of overweight and obesity in a large sample of American Indian children from a survey in 2002-2003, and to evaluate the change in prevalences since 1995-1996 when children on the same reservations were measured.

Design: Analysis of survey data.

Setting: Aberdeen Area Indian Health Service (North Dakota, South Dakota, Iowa, and Nebraska).

Participants: A total of 11,538 American Indian children (aged 5-17 years) attending 55 schools on 12 reservations.

Main Outcome Measure: Height and weight measured during the 2002-2003 school year by the same team as in the earlier survey. Prevalences of overweight (≥85th percentile) and obesity (≥95th percentile) were calculated on the basis of body mass index (calculated as weight in kilograms divided by the square of height in meters) and the Centers for Disease Control and Prevention growth charts.

Results: At 5 years of age, 47% of boys and 41% of girls were overweight, and 24% of the children were obese. Prevalences of overweight and obesity exceeded those for the most recent available data for all US children at almost every age. In the intervening 7 to 8 years between surveys, prevalences of overweight and obesity continued to increase in the children by 4.5% and 4.3%, respectively.

Conclusions: Prevalences of overweight and obesity in the most recent sample of American Indian children indicate that they are at even higher risk for these conditions and their health-related sequelae than the best estimates for all US children, with prevalences as high as or higher than those for any other racial or ethnic groups of children reported in the most recent national surveys.

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The high levels of overweight and obesity among US children are a major public health concern. The National Health and Nutrition Examination Survey (NHANES) data have shown steady increases in child and adolescent overweight and obesity during the past 2 decades.1-3 The NHANES data also indicate continuing disparities between racial and ethnic groups in the prevalence of obesity, with rates considerably higher for ethnic minority youth compared with white youth.1,2 In NHANES data from 1999 to 2002 for youth aged 6 to 19 years, 28% of white youth, 35% of African American youth, and 40% of Mexican American youth had a body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters) greater than the 85th percentile for age and sex.3 Recent analyses from the National Longitudinal Survey of Youth, a prospective cohort study from 1986 to 1998 among 8270 children aged 4 to 12 years, found that while overweight increased significantly and steadily among African American, Hispanic, and white children, overweight prevalence was greatest and increased most rapidly among minority children.4

Another group at high risk for overweight and obesity is American Indian children. Overweight and obesity rates for American Indian children, adolescents, and adults tend to be notably higher than corresponding rates for the general US population.5,6 While several studies have examined the prevalence of overweight in American Indian children, most of these have had relatively small sample sizes and have not been population-based studies. Relatively few large studies have been conducted with American Indian youth. In 1990, a national survey on height and weight status of 9464 American Indian schoolchildren (aged 5-18 years) living on or near Indian reservations was conducted by the Indian Health Service (IHS), the Centers for Disease Control and Prevention, and tribal nutrition programs in 9 IHS service areas.7 The overall preva-
lence of overweight in the American Indian children (BMI, ≥85th percentile of the reference population) was 39% for age and sex according to NHANES II reference data. In 1995-1996, our group conducted a large study on overweight and obesity prevalence in American Indian school children through the Aberdeen Area IHS and involved children from 16 tribes in 4 midwestern states. Height and weight were measured on 12,559 Indian children aged 5 to 17 years attending 62 schools on or near reservations in South Dakota, North Dakota, Iowa, and Nebraska. Age-adjusted prevalences of overweight (BMI, ≥85th percentile for NHANES II) were 39% for boys and 38% for girls. The age-adjusted prevalences of obesity (BMI, ≥95th percentile) for boys and girls were 22% and 18%, respectively.

These as well as other studies have all shown a high prevalence of obesity among American Indian youth. Indeed, obesity has now emerged as one of the most serious public health problems facing American Indian children and adolescents. Because of the secondary health consequences of obesity, including cardiovascular disease and type 2 diabetes mellitus, there are grave implications for both the immediate and long-term health of American Indian youth. Accordingly, there is a need to monitor overweight trends in American Indian children. The NHANES data have shown continuing increases in overweight among US children and youth. Unfortunately, NHANES does not include American Indians living on reservations in its sampling design. The aims of this study were (1) to assess overweight and obesity in a large sample of American Indian school-aged children and adolescents living on or near reservations in the Aberdeen Area IHS area and (2) to investigate recent changes in the prevalence of overweight and obesity compared with the study conducted in 1995-1996 with children on the same reservations.

METHODS

The analyses included data from 2 surveys of children attending primary and secondary schools at which at least 50% of enrolled children were identified as American Indian and that were located on or near the reservations included in the Aberdeen Area IHS. This IHS comprises 18 tribes in North Dakota, South Dakota, Nebraska, and Iowa.

For estimating current prevalences of overweight and obesity, data obtained during the 2002-2003 school year were used. Height and weight data were collected on 11,538 children attending 55 schools on 12 reservations (survey 2). For evaluating secular changes in prevalences, data from the most recent survey for children living on 8 of the reservations from survey 2 were compared with data from a sample of children living on the same reservations who were measured in 1995 and 1996 by the same measurement team (survey 1). The samples were limited to children from 5.00 to 17.99 years of age at the time of measurement, and to children who identified themselves or who were identified by teachers as American Indian. Cases with extreme values of height or weight were excluded if measurements exceeded the median ± 3 times the interquartile range, calculated within whole-year, sex-specific groups.

After the exclusions, the sample from survey 2 used to estimate current prevalences included data for 5,508 boys and 5,313 girls. For estimating secular changes in prevalences, the samples included 4,763 boys and 4,727 girls from survey 1 and 4,835 boys and 4,632 girls from survey 2. There were no significant differences between prevalences of overweight and obesity estimated from the subset of children in survey 2 used for the secular-change analyses and the complete sample in survey 2.

All children were measured by the same 7 trained individuals following the same protocols, and all measurements were standardized according to a gold-standard measurement. Weights were obtained with electronic scales (Seca Corp, Columbia, Md), which were regularly calibrated. Heights were measured with a stadiometer (Acus tat; Ross Laboratories, Columbus, Ohio). Informed parental consent was obtained according to individual school policies. In some schools, measurements were incorporated into regular health-screening activities. All procedures were approved by the appropriate institutional review boards for tribes and the IHS.

Overweight was defined as BMI at or above the 85th percentile for age and sex, based on the Centers for Disease Control and Prevention 2000 growth charts, and obesity was defined as BMI at or above the 95th percentile according to the same reference. Exact BMI percentiles were calculated with Epi Info 2000 computer software (Centers for Disease Control and Prevention, Atlanta, Ga.).

The prevalences of overweight and obesity from survey 2 calculated within single-year age groups were compared with recent national data available from NHANES 1999 to 2002 for children of all racial or ethnic groups. Prevalences for NHANES data were calculated using the case weights provided to account for the probability of sampling.

Prevalence estimates were made and analyzed by coding overweight and obesity as separate dichotomous variables (0 and 1), based on the BMI percentile cutoffs specific to sex and age. This approach to estimating prevalence provides means that are unbiased estimates of prevalence for groups, and binomial distributions that approximate normality because of the large sample sizes. Prevalences of overweight and obesity were calculated within whole-year age groups (eg, 10 years = 10.00-10.99 years) within each sex.

For analyses of the secular changes between surveys, mixed models were fitted. The dependent variable was status as overweight or obese (0 or 1). Survey, sex, and whole-year age group were fixed categorical independent variables, and reservation was included as a random categorical variable to account for possible similarities within reservations for overweight and obesity. All interactions among independent variables were evaluated. Adjusted prevalences within groups were estimated as the least squares means from the fully adjusted mixed models.

RESULTS

The prevalences of overweight and obesity among the American Indian children measured in 2002 and 2003 are presented in Table 1. In general, the prevalences of overweight and obesity were slightly greater in boys than girls until the early teen years, when the trend reversed. At 5 years of age, more than 40% of the American Indian children had BMIs equal to or greater than the 85th percentile and almost one quarter of them had BMIs that equaled or exceeded the 95th percentile. At 11 years, more than half of the American Indian children were overweight.

Prevalences of overweight and obesity in the American Indian children are compared with corresponding
prevalences for all US children in Figure 1 and Figure 2. At almost every age, the prevalences of both overweight and obesity among American Indian (AI) boys (survey 2, 2002-2003) and among all US boys (National Health and Nutrition Examination Survey, 1999-2002) by age groups.

The adjusted prevalences from the mixed-model analysis of variance testing for overall changes between survey 1 (1995-1996) and survey 2 (2002-2003) for children living on the same 8 reservations are presented in Table 2. There were statistically significant increases in prevalences of overweight ($P<.001$) and obesity ($P<.001$) during the time between the 2 surveys (5-7 years). Also, there were significant main effects for sex (overweight, $P=.02$; obesity, $P<.001$) and age (overweight, $P<.001$; obesity, $P<.001$), but not for the interactions between survey and age (overweight, $P=.10$; obesity, $P=.58$), nor for any other interaction terms. The lack of significant interaction terms with survey indicates that there were no substantial differences between sexes or among the age groups in their patterns of secular change in prevalence of overweight and obesity. The adjusted prevalences (Table 2) indicate that the absolute changes in prevalences between surveys were 4.5% and 4.3% for overweight and obesity, respectively.

The data for boys are presented in Figure 3 as an example of the age-related patterns in the changes in prevalences of overweight and obesity among the American Indian children between surveys. Secular increases occurred at almost all ages, and to a generally similar degree for overweight and obesity at most ages. The secu-

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Table 1. Prevalence of Overweight ($\geq 85$th Percentile of BMI) and Obesity ($\geq 95$th Percentile of BMI) in North American Indian Children by Sex and Age Group (2002-2003)

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Boys</th>
<th></th>
<th>Girls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Overweight, %</td>
<td>Obesity, %</td>
<td>No.</td>
</tr>
<tr>
<td>5</td>
<td>302</td>
<td>47.4</td>
<td>24.2</td>
<td>311</td>
</tr>
<tr>
<td>6</td>
<td>477</td>
<td>44.7</td>
<td>22.4</td>
<td>450</td>
</tr>
<tr>
<td>7</td>
<td>510</td>
<td>43.9</td>
<td>26.1</td>
<td>483</td>
</tr>
<tr>
<td>8</td>
<td>500</td>
<td>47.0</td>
<td>27.8</td>
<td>476</td>
</tr>
<tr>
<td>9</td>
<td>581</td>
<td>48.7</td>
<td>29.8</td>
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<td>10</td>
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<td>538</td>
</tr>
<tr>
<td>12</td>
<td>514</td>
<td>53.9</td>
<td>35.0</td>
<td>471</td>
</tr>
<tr>
<td>13</td>
<td>459</td>
<td>48.4</td>
<td>30.5</td>
<td>484</td>
</tr>
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<td>14</td>
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<tr>
<td>15</td>
<td>283</td>
<td>39.9</td>
<td>25.1</td>
<td>264</td>
</tr>
<tr>
<td>16</td>
<td>211</td>
<td>38.4</td>
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<td>220</td>
</tr>
<tr>
<td>17</td>
<td>199</td>
<td>36.7</td>
<td>20.1</td>
<td>148</td>
</tr>
<tr>
<td>Total*</td>
<td>5508</td>
<td>48.1</td>
<td>29.4</td>
<td>5313</td>
</tr>
</tbody>
</table>

95% CI: 46.7-49.4 28.2-30.6 44.9-47.7 24.9-27.3

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); CI, confidence interval.

*Age-adjusted.

Figure 1. Prevalences of overweight (body mass index [calculated as weight in kilograms divided by the square of height in meters], $\geq 85$th percentile) and obesity (body mass index, $\geq 95$th percentile) among American Indian (AI) boys (survey 2, 2002-2003) and among all US boys (National Health and Nutrition Examination Survey, 1999-2002) by age groups.

Figure 2. Prevalences of overweight (body mass index [calculated as weight in kilograms divided by the square of height in meters], $\geq 85$th percentile) and obesity (body mass index, $\geq 95$th percentile) among American Indian (AI) girls (survey 2, 2002-2003) and among all US girls (National Health and Nutrition Examination Survey, 1999-2002) by age groups.
lar decreases in prevalences of overweight at age 7 years and obesity at age 17 years are apparent, but they are not sufficient to conclude a significant interaction between age and survey based on our analysis of variance models used to evaluate change. Similar general patterns of secular change in prevalences were seen on examination of corresponding data for girls (data not shown).

The age-adjusted prevalences of overweight (BMI, ≥85th percentile) among these American Indian children aged 5 to 17 years during 2002-2003 were 48.1% in boys and 46.3% in girls. Corresponding prevalences for obesity (BMI, ≥95th percentile) were 29.4% and 26.1% for boys and girls, respectively. These levels are very high and indicate substantial health risk.6 Although direct comparisons with previous studies in American Indians are complicated by the use of slightly different earlier BMI cutoffs, we are aware of no studies of American Indian children reporting higher prevalences of overweight and obesity.6,19 We believe that the high prevalences among the current sample of American Indian children primarily result from the recency of the data for this cultural/ethnic group with markedly increasing prevalences over time.19,20 The BMI and body composition data from the study by Caballero et al17 indicate that percentage of body fat and obesity prevalences for American Indian children from the Aberdeen area in 1995-1996 did not differ appreciably from those of children in 5 other national tribal groups.

The prevalences of overweight and obesity among American Indian children in this study systematically exceeded those for the most recent data available for all US children (Figures 1 and 2). Some recent national data are available for comparisons according to sex and race or ethnicity.1 American Indian children aged 6 to 11 years exceeded each racial or ethnic group described nationally in point prevalences for obesity (boys, 29.8%; girls, 25.7%) but were probably within the confidence intervals of the estimates for the racial or ethnic groups with the highest prevalences: Mexican American boys (27.3%) and black or African American girls (22.1%).1 The older American Indian children (12-17 years) had prevalences of obesity (boys, 27.4%; girls, 26.8%) similar to those for Mexican American boys (27.5%) and black or African American girls (26.6%), the sex and racial-ethnic groups with the highest reported prevalences in the national survey of children aged 12 to 19 years.1

The age-specific data in Table 1 indicate a general trend of increasing prevalences of overweight and obesity from ages 5 until 11 years in boys and 12 years in girls, after which the prevalences generally decreased through the later adolescent years. Nevertheless, because the data are cross-sectional, any age-related changes in prevalences that might be interpreted as developmental are completely confounded by the secular changes that occurred. The data from the earlier survey 1 (1996-1997) of American Indian chil-

### Table 2. Adjusted Prevalences of Overweight and Obesity From Full Model for Each Survey and Sex

<table>
<thead>
<tr>
<th></th>
<th>Overweight</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey 1</td>
<td>42.0 (41.9-42.1)</td>
<td>22.7 (22.5-22.8)</td>
</tr>
<tr>
<td>Survey 2</td>
<td>46.4 (46.3-46.5)</td>
<td>27.5 (27.4-27.6)</td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survey 1</td>
<td>42.6 (42.5-42.7)</td>
<td>25.5 (25.4-25.6)</td>
</tr>
<tr>
<td>Survey 2</td>
<td>47.3 (47.2-47.4)</td>
<td>29.2 (29.1-29.3)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

American Indian children (12-17 years) had prevalences of obesity (boys, 29.8%; girls, 25.7%) but were probably within the confidence intervals of the estimates for the racial or ethnic groups with the highest prevalences:

- Mexican American boys (27.3%)
- Black or African American girls (22.1%)

The older American Indian children (12-17 years) had prevalences of obesity (boys, 27.4%; girls, 26.8%) similar to those for Mexican American boys (27.5%) and black or African American girls (26.6%), the sex and racial-ethnic groups with the highest reported prevalences in the national survey of children aged 12 to 19 years.

The age-specific data in Table 1 indicate a general trend of increasing prevalences of overweight and obesity from ages 5 until 11 years in boys and 12 years in girls, after which the prevalences generally decreased through the later adolescent years. Nevertheless, because the data are cross-sectional, any age-related changes in prevalences that might be interpreted as developmental are completely confounded by the secular changes that occurred. The data from the earlier survey 1 (1996-1997) of American Indian chil-

![Figure 3. Differences in prevalences of overweight (body mass index [calculated as weight in kilograms divided by the square of height in meters], ≥85th percentile) and obesity (body mass index, ≥95th percentile) between survey 1 (1996-1997) and survey 2 (2002-2003) for American Indian boys. Differences were calculated as survey 2 minus survey 1.](https://www.archpediatrics.com/content/160/1/60.full.pdf)
Obesity is highly related to the development of type 2 diabetes in American Indian children and adolescents, and is associated with the rapid increase in type 2 diabetes mellitus trajectories for cardiovascular disease and other chronic diseases of overweight and obesity. While the problem of overweight and obesity is found that early childhood obesity at age 5 years was the dominant predictor of obesity at age 10 years. It is not clear at what age overweight and obesity begin in American Indian children, but primary prevention probably should begin at ages younger than 5 years.

Obesity is a multifactorial condition stemming from complex interactions between genetic and environmental factors. Dietary and physical activity behaviors are potentially modifiable and can be targets for change in obesity prevention and intervention efforts. Culturally tailored strategies are needed to increase physical activity and encourage healthy eating among children and their families. Efforts are also needed to produce an environment that supports healthy eating and physical activity in the community. Many reservations are environmentally impoverished. Poverty and living in low-income communities limit access to healthy foods. To successfully combat the obesity and diabetes epidemics and help children achieve healthy weight trajectories, low-income families and communities need supportive environments with increased availability and affordability of healthier foods, such as fruits and vegetables, in grocery stores, convenience stores, commodity distribution sites, and schools. Increased play and physical activity opportunities are needed. We believe prevention of obesity in American Indian children and youth must be a public health priority. American Indian children often have been overlooked when groups at risk are identified, perhaps because they have not been adequately sampled in many surveys. Without immediate intervention, all indications are that the current generation of Indian children will face an increased burden of obesity-related chronic diseases, including type 2 diabetes and heart disease, at increasingly younger ages, which will have devastating effects on American Indian communities.

Since American Indian reservations are not included in the NHANES sampling surveys, there is a need to strengthen and develop surveillance systems to assess heights and weights in American Indian youth and monitor trends in obesity within and across reservations. Prevention and intervention efforts will be enhanced by more studies that examine the behavioral, social, genetic, and environmental factors that contribute to the development of obesity in American Indian children.

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Author Contributions: Dr Himes had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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REFERENCES


If you want to see what children can do, you must stop giving them things.
—Norman Douglas