

Body composition assessment in American Indian children¹⁻³

Timothy G Lohman, Benjamin Caballero, John H Himes, Sally Hunsberger, Raymond Reid, Dawn Stewart, and Betty Skipper

ABSTRACT

Although the high prevalence of obesity in American Indian children was documented in several surveys that used body mass index (BMI, in kg/m²) as the measure, there is limited information on more direct measurements of body adiposity in this population. The present study evaluated body composition in 81 boys (aged 11.2 ± 0.6 y) and 75 girls (aged 11.0 ± 0.4 y) attending public schools in 6 American Indian communities: White Mountain Apache, Pima, and Tohono O'odham in Arizona; Oglala Lakota and Sicangu Lakota in South Dakota; and Navajo in New Mexico and Arizona. These communities were participating in the feasibility phase of Pathways, a multicenter intervention for the primary prevention of obesity. Body composition was estimated by using a combination of skinfold thickness and bioelectrical impedance measurements, with a prediction equation validated previously in this same population. The mean BMI was 20.4 ± 4.2 for boys and 21.1 ± 5.0 for girls. The sum of the triceps plus subscapular skinfold thicknesses averaged 28.6 ± 7.0 mm in boys and 34.0 ± 8.0 mm in girls. Mean percentage body fat was 35.6 ± 6.9 in boys and 38.8 ± 8.5 in girls. The results from this study confirmed the high prevalence of excess body fatness in school-age American Indian children and permitted the development of procedures, training, and quality control for measurement of the main outcome variable in the full-scale Pathways study. *Am J Clin Nutr* 1999;69(suppl):764S-6S.

KEY WORDS Body composition, obesity, body fat, adiposity, American Indians, Native Americans, school-age children, schoolchildren, skinfold thickness, bioelectrical impedance, body mass index

INTRODUCTION

The third National Health and Nutrition Examination Survey (NHANES III), conducted from 1988 through 1991, revealed an alarming increase in the prevalence of obesity in children and adolescents (1). During the past 30 y, the prevalence of overweight [defined as body mass index (BMI, in kg/m²) ≥ 85th percentile] in children aged 6-11 y has increased from 15.2% to 22.3% (1). In American Indians, Broussard et al (2) found that the prevalence of overweight at similar ages (using the 85th percentile of NHANES II as a cutoff) was 30-46% in boys and 35-43% in girls. Prevalence figures varied from 25% to 46% for different tribes and regions of the United States.

Although considerable amounts of data on American Indian children have been collected using height and weight (2, 3), data

on more direct measures of body fatness are limited. This information is important for assessing the degree of obesity in young children more directly and for evaluating the effect of prevention programs. The present study was designed to estimate body composition in American Indian children living in 6 different Indian nations throughout the United States.

SUBJECTS AND METHODS

Body fatness was estimated in 81 boys (mean age 11.2 ± 0.6 y) and 75 girls (mean age 11.0 ± 0.4 y) attending fifth grade in public schools serving 6 American Indian communities: White Mountain Apache, Tohono O'odham, and Pima (in Arizona); Oglala Lakota and Sicangu Lakota (in South Dakota); and Navajo (in New Mexico and Arizona). Measurements were organized and performed at 4 different field centers participating in the feasibility phase of Pathways, a collaborative obesity-prevention intervention. Body composition was predicted from height, weight, triceps and subscapular skinfold thicknesses, and bioelectrical resistance and reactance by using a specific equation validated previously in this population (see equation 1). Informed consent was obtained from a parent or legal guardian of each child. The study protocol was approved by local school and tribal authorities and the Human Subjects Committees of the University of Arizona, the Johns Hopkins University, the University of Minnesota, and the University of New Mexico.

The following formula was used to estimate percentage body fat from the 2 skinfold thickness measurements, bioelectrical impedance measurements, age, weight, and sex. The formula was developed by using data from a sample of 98 American Indian children with a mean age of 11 y (TG Lohman, B Caballero, J Himes, et al, unpublished observations, 1996):

¹From the Department of Physiology, University of Arizona, Tucson; the Center for Human Nutrition and the School of Hygiene and Public Health, the Johns Hopkins University, Baltimore; the Division of Epidemiology, University of Minnesota, Minneapolis; the National Heart, Lung, and Blood Institute of the National Institutes of Health, Bethesda, MD; the Department of Biostatistics, University of North Carolina, Chapel Hill; and Family and Community Medicine, University of New Mexico, Albuquerque.

²Supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health (U01-HL-50869, U01-HL-50867, U01-HL-50905, U01-HL-50885, and U01-HL-50907).

³Address reprint requests to TG Lohman, 114 Ina Gittings Building, University of Arizona, Tucson, AZ 85721. E-mail: lohman@u.arizona.edu

$$\begin{aligned} \text{Percentage body fat} = & -0.49\text{age} + 0.51\text{sex} \\ & + 0.44\text{weight} + 1.55\text{triceps skinfold thickness} \\ & + 0.15\text{subscapular skinfold thickness} \\ & + 0.54(S^2/R) + 0.13\text{reactance} \\ & - 0.04\text{triceps skinfold thickness} \\ & \times S^2/R - 10.91 \end{aligned} \quad (1)$$

where sex is coded 1 for girls and 0 for boys, weight is in kg, skinfold thickness is in mm, S is height, R is resistance in ohms, and reactance is in ohms. The SEE for percentage body fat was 3.4%.

The following equation, which uses only age, sex (intercept differs for boys and girls), and BMI, was also used (TG Lohman et al). It allows the estimation of percentage body fat from previously collected BMI data.

$$\text{Percentage body fat} = 0.39\text{age} + 1.46\text{BMI} + \text{intercept} \quad (2)$$

where the intercept is +1.71 for girls and -2.23 for boys. The SEE for percentage body fat was 4.3%.

Before any collection of data from the children, the measurement staff from each field center was trained at one central location to perform all body composition measurements. A separate reliability study was performed after training. All 14 staff trainees measured 4 children (2 sets of 2 children randomly assigned to each pair of observers) to assess interobserver measurement reliability. Intraclass correlation coefficients were calculated by using a random effects model of pooled data from all trainees. A total of 21 children were measured to assess reliability.

RESULTS

The results of the reliability analyses based on data from 14 observers trained in measurement procedures for the body composition variables are presented in Table 1. The intraclass correlations ranged from 0.999 for body weight to 0.69 for triceps skinfold thickness. The reliability coefficients were somewhat lower for skinfold thicknesses because the sample had lower variability than expected. In general, the coefficients are in the acceptable range for the reliability of anthropometric data. The body composition data from the 4 field centers were combined and are summarized in Table 2. The mean BMI was 20.4 for boys and 21.1 for girls. The sum of the triceps skinfold and subscapular skinfold thicknesses averaged 28.6 mm for boys and 34.0 mm for girls. The mean percentage body fat, calculated by using equation 1, was 35.6 for boys and 38.8 for girls.

TABLE 1
Interobserver reliability of anthropometric and bioelectric impedance measurements¹

	Mean ± SD	r ²
Height (cm)	152.40 ± 8.94	0.998
Weight (kg)	40.32 ± 7.60	0.999
Triceps skinfold (mm)	13.0 ± 3.8	0.69
Subscapular skinfold (mm)	7.4 ± 2.4	0.80
Bioelectrical impedance		
Resistance (Ω)	683.2 ± 82.5	0.93
Reactance (Ω)	86.4 ± 15.5	0.76

¹n = 14 observers of 21 children.

²Intraclass correlation.

TABLE 2
Body composition of American Indian children studied at 4 field centers¹

	Boys (n = 81)	Girls (n = 75)
Age (y)	11.2 ± 0.6	11.0 ± 0.4
BMI (kg/m ²)	20.4 ± 4.2	21.1 ± 5.0
Triceps skinfold thickness (mm)	16.4 ± 6.9	18.3 ± 7.0
Subscapular skinfold thickness (mm)	12.2 ± 7.2	15.7 ± 9.0
Percentage body fat (%)	35.6 ± 6.9	38.8 ± 8.5

¹ $\bar{x} \pm SD$. Percentage body fat was estimated from skinfold thickness and bioelectric impedance measurements by using equation 1.

The results from this sample of children are comparable to those of Jackson (3), who assessed the weight and height of American Indian children ranging from 6 to 11 y (Table 3). The mean BMI for 11-y-olds was 21.7 for boys and 21.3 for girls (3). When we estimated the percentage body fat in this sample by using BMI in equation 2, the results indicated that 11-y-old boys had 33.7% body fat and girls of the same age had 37.1% body fat (Table 3). The body composition data for our sample are shown by field center in Table 4.

DISCUSSION

Based on BMI data, Jackson (3) and Broussard et al (2) concluded that the prevalence of obesity is high in the children and youth of many American Indian communities. The need to more accurately assess body fatness in the American Indian population is particularly urgent because previous studies used only BMI to estimate the prevalence of overweight. Because BMI reflects both fat-free mass and fat mass, it is difficult to assess obesity without using more direct methods of evaluating body composition. The present study was designed to use such methods to obtain information on body composition in American Indian children. Equation 1, which was derived previously from 98 American Indian children and which uses skinfold thickness and bioelectrical impedance measurements to determine percentage body fat, was applied to data from 81 boys and 75 girls evaluated at 4 field centers.

The mean BMI and percentage body fat in our sample were considerably above the national norms for 11-y-old children as reported by Kuczmarski (4), supporting the evidence from previous investigations of the widespread prevalence of obesity in

TABLE 3
Mean BMI (in kg/m²) and percentage body fat in American Indian children¹

Age (y)	Boys		Girls	
	BMI	Percentage body fat %	BMI	Percentage body fat %
6	17.2	25.2	17.0	28.9
7	17.9	26.6	18.1	30.9
8	19.1	28.8	18.4	31.7
9	19.4	29.6	19.6	33.8
10	20.5	31.6	20.3	35.2
11	21.7	33.7	21.3	37.1

¹Age and BMI data are from reference 3. Percentage body fat was calculated as follows: Boys: Percentage body fat = 0.39age + 1.46BMI - 2.23; Girls: Percentage body fat = 0.39age + 1.46BMI + 1.71.

TABLE 4
Body composition of American Indian children by field center¹

	Field center			
	1	2	3	4
Girls				
Age (y)	11.0 ± 0.4	11.2 ± 0.5	11.1 ± 0.2	10.8 ± 0.5
BMI (kg/m ²)	20.6 ± 3.7	23.4 ± 5.0	19.5 ± 4.5	20.9 ± 6.3
Percentage				
body fat (%)	41.6 ± 7.6	40.4 ± 7.2	35.4 ± 8.8	36.7 ± 9.2
Boys				
Age (y)	11.4 ± 0.6	11.0 ± 0.8	11.2 ± 0.4	11.0 ± 0.5
BMI (kg/m ²)	20.5 ± 4.4	22.2 ± 5.1	19.1 ± 4.5	20.0 ± 3.2
Percentage				
body fat (%)	37.2 ± 7.3	37.8 ± 6.9	32.6 ± 6.3	34.0 ± 6.1

¹ $\bar{x} \pm$ SD. Percentage body fat was estimated from skinfold thickness and bioelectric impedance measurements by using equation 1.

American Indian children. The BMI results of our sample of 11-y-old American Indian children (\bar{x} = 20.4 and 21.1 for boys and girls, respectively) are similar to those of Jackson (3) for 419 boys and 384 girls attending school in 19 states during 1990 and 1991 (Table 3). The BMI cutoff point for 11-y-old children, based on the 85th percentile for height and weight using National Health and Examination Survey (NHES) data, was 20.9 for boys and 21.7 for girls. The mean of the sum of 2 skinfold thicknesses for

our sample of children was 28.6 and 34.0 mm for boys and girls, respectively. These levels are close to the 85th percentile for the NHES national sample of 11-y-olds (28 mm for boys and 31 mm for girls) (5).

The findings of the present study confirm that there is a high prevalence of obesity in American Indian children representing 6 different Indian nations. The present study also developed and performed the procedures, training, and reliability testing for the anthropometric measurements used in the full-scale Pathways intervention. 

REFERENCES

1. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents. *Arch Pediatr Adolesc Med* 1995;149:1085–91.
2. Broussard BA, Sugarman JR, Bachman-Carter K, et al. Toward comprehensive obesity prevention programs in Native American communities. *Obes Res* 1995;3(suppl):289S–97S.
3. Jackson, MY. Height, weight and body mass index of American Indian school children, 1990–1991. *J Am Diet Assoc* 1993;93:1136–40.
4. Kuczmarski RJ. Trends in body composition for infants and children in the US. *Crit Rev Food Sci Nutr* 1993;33:375–87.
5. Lohman, TG. Advances in body composition assessment. Current issues in exercise science series. Monograph 3. Champaign, IL: Human Kinetics Publishers, 1992.

