See corresponding editorial on page 199.

Body composition and overweight prevalence in 1704 schoolchildren from 7 American Indian communities[1–3]

Benjamin Caballero, John H Himes, Timothy Lohman, Sally M Davis, June Stevens, Marguerite Evans, Scott Going, and Juanita Pablo for the Pathways Study Research Group

ABSTRACT

Background: Nationwide data on obesity prevalence in American Indian communities are limited.

Objective: We describe the body composition and anthropometric characteristics of schoolchildren from 7 American Indian communities enrolled in the Pathways study, a randomized field trial evaluating a program for the primary prevention of obesity.

Design: A total of 1704 children in 41 schools were enrolled in the study. Basic anthropometric measurements included weight, height, and triceps and subscapular skinfold thicknesses. Percentage body fat was estimated from bioelectrical impedance and anthropometric variables with the use of an equation developed and validated for this population.

Results: The children's mean (± SD) age was 7.6 ± 0.6 y, and their mean weight and height were 32.1 ± 8.9 kg and 129.8 ± 6.3 cm, respectively. Mean body mass index (BMI; in kg/m^2) was 18.8 ± 3.9, and mean percentage body fat was 32.6 ± 6.8%. With the use of current Centers for Disease Control and Prevention reference values, 30.5% of girls and 26.8% of boys were above the 95th percentiles for BMI-for-age, and 21% of girls and 19.6% of boys were between the 85th and 95th percentiles. Although there was a wide range in BMI across study sites and for both sexes, the percentage of children with a BMI above the 95th percentile was consistently higher than the national averages in all communities studied and in both girls and boys.

Conclusions: Overweight can be documented in a substantial number of American Indian children by the time they reach elementary school. Despite differences in the prevalence of overweight observed among communities, rates are uniformly high relative to national all-race averages. *Am J Clin Nutr* 2003;78:308–12.

KEY WORDS Body composition, obesity, American Indians, obesity prevention, children

INTRODUCTION

The alarming increase in the number of US children who are overweight [body mass index (BMI)-for-age > 95th percentile] or at risk of overweight (BMI-for-age between the 85th and 95th percentiles) has been emphasized in several recent reports (1, 2). A comparison of data from several national surveys shows that the percentage of 6–11-y-old children with a BMI above the 85th percentile (with use of the 1963 National Health Examination Survey as a reference) increased from 15% in 1963 to 22% in 1994. The reasons for this increasing prevalence are not completely clear, but it is believed that a sedentary lifestyle and unhealthy dietary habits (eg, excessive consumption of high-fat snacks and soft drinks) may play a role (3).

Nationwide data on obesity prevalence in American Indian communities are limited. Data from specific tribes and from surveys of adult American Indian groups reported by the US Indian Health Service show prevalences of overweight [BMI (in kg/m^2) ≥ 27.8 for men and ≥ 27.3 for women] of 34% for men and 40% for women, compared with national averages of 24.1% for men and 25.0% for women with use of the same criteria (4, 5). Although prevalence data for American Indian children are even more limited than for adults, a 1990 survey that examined 9464 American Indian children aged 5–18 y found that 39% had a BMI above the 85th percentile [based on the second National Health and Nutrition Examination Survey (NHANES II)] (6). Similar frequencies were found in a large survey of schoolchildren in the Aberdeen area of the Indian Health Service (7). Other smaller surveys in specific tribes also reported prevalences in children of BMI above the 85th percentile of 25–46% (8, 9). None of these surveys included specific measurements of body fat (10).

The Pathways study was a randomized trial designed to evaluate a program for the primary prevention of obesity, targeting elementary school children in grades 3–5. The intervention included components related to physical activity, food service, classroom curriculum, and family involvement. The aim of the Pathways intervention was to produce a difference of ≥ 3% in mean percentage body fat between the intervention and control schools by the end of the 5th grade. Details of the intervention program and results from the feasibility studies that preceded the full-scale intervention are reported elsewhere (11, 12). The present report describes the results of baseline body-composition measurements in the 1705 children enrolled

[1] From the Center for Human Nutrition, Johns Hopkins University, Baltimore (BC); the Division of Epidemiology, University of Minnesota, Minneapolis (JHH); the Department of Physiology, University of Arizona, Tucson (TL and SG); the Department of Pediatrics, University of New Mexico, Albuquerque (SMD); the Departments of Nutrition and Epidemiology, University of North Carolina at Chapel Hill (JS); the National Heart, Lung, and Blood Institute, Bethesda, MD (ME); and the Tohono O'odham Nation, Sells, AZ (JP).

[2] Supported by the National Heart, Lung, and Blood Institute (grants U01-HL-50869, -50867, -50905, -50885, and -50907).

[3] Address reprint requests to B Caballero, Center for Human Nutrition, Johns Hopkins University, 615 North Wolfe Street, Baltimore, MD 21205. E-mail caballero@jhu.edu.

Received October 1, 2002.

Accepted for publication February 28, 2003.

TABLE 1
Anthropometric characteristics and body composition of the children studied[1]

		Percentiles			
	$\bar{x} \pm$ SD	5	25	75	95
Age (y)	7.6 ± 0.6	7	7	8	9
Weight (kg)	32.1 ± 8.9	22.5	26.2	35.8	49.3
Height (cm)	129.8 ± 6.3	119.9	125.5	133.9	140.8
BMI (kg/m^2)	18.8 ± 3.9	14.8	16.2	20.4	26.3
Body fat (%)	32.6 ± 6.8	23.7	27.5	36.9	45.8
Skinfold thickness (mm)					
Subscapular	10.3 ± 6.4	4.0	5.7	13.0	24.0
Triceps	13.0 ± 5.5	6.0	9.0	16.0	23.7

[1] n = 1704.

in the Pathways study and discusses these data in the context of national anthropometric surveys conducted in comparable age groups.

SUBJECTS AND METHODS

The Pathways study enrolled 41 schools serving 7 American Indian communities: White Mountain Apache, San Carlos Apache, Navajo, Sicangu Lakota, Oglala Lakota, Tohono O'odham, and Gila River Indian Community (Pima-Maricopa). The study was organized in 4 field sites—2 in Arizona, 1 in New Mexico, and 1 in South Dakota—and a data processing and coordinating center in North Carolina. To avoid interfering with the initiation of the intervention at the beginning of 3rd grade, children were enrolled at the end of 2nd grade, in the spring of 1997, and the intervention was carried out from the fall of that year through the spring of 2000. The study protocol was approved by the appropriate academic, school, and tribal authorities, and written consent from parents and verbal consent from children were obtained.

All measurements were performed at the schools. At least 80% of eligible children at each participating school were measured. Staff personnel from each field center were trained at a central location. The training included certification and cross-validation across study sites.

Children were asked to wear loose clothing, and shoes and jewelry were removed before measurement. Standing height was measured in duplicate with a Shorr vertical measuring board (Shorr Production, Olney, MD) by following previously described protocols (13) and was recorded to the nearest 0.1 cm. Body weight was measured, also in duplicate, by using portable, strain-gauge digital scales (Seca Model 770; Vogel & Halke GmbH & Co, Hamburg, Germany) and was recorded to the nearest 0.1 kg.

Triceps and subscapular skinfold thicknesses were measured to the nearest millimeter by using Lange (Cambridge, MD) skinfold calipers (13). The average of 3 trials was used as the final value for each subject.

Bioelectrical impedance measurements (resistance and reactance) were made on the right side of the body by using a 4-terminal, single-frequency (800 μA at 50 kHz) impedance plethysmograph (model 1990B; Valhalla Scientific, Valhalla, NY). Children were measured in the morning and were well-hydrated and resting while waiting. All measurements were performed in the school's infirmary or in a designated room that allowed privacy during the procedures. Two measurements were taken on each subject and the average of the 2 trials was used as the final value for each subject (14). Before each session, the instrument was calibrated by using 500 ± 1 Ω external resistors and by using the internal calibration system of the analyzer.

FIGURE 1. Distribution of percentage body fat in boys (-----) and girls (—) enrolled in the Pathways study. Percentage body fat was calculated by using an equation that included bioelectrical impedance and subscapular and triceps skinfold thicknesses.

Quality control was done by remeasuring every 10th child. Readings beyond acceptable ranges resulted in the temporary exclusion of the operator who performed that measurement. After retraining and certification (usually within 48 h), the operator was reinstated to the measurement team.

Data analysis

Percentage body fat was estimated by using an equation previously validated in this population. The equation included weight, age, sex, resistance, reactance, and triceps and subscapular skinfold thicknesses (15).

$$\begin{aligned}\text{Body fat (\%)} &= -0.4940 \times \text{age} + 0.6102 \times \text{sex} \\ &+ 0.4432 \times \text{wt} + 1.5497 \times \text{triceps skinfold thickness} \\ &+ 0.1459 \times \text{subscapular skinfold thickness} \\ &+ 0.5373 \times S^2/R + 0.1258 \times \text{reactance} - 0.039 \\ &\times \text{triceps skinfold thickness} \times S^2/R - 10.9071 \qquad (1)\end{aligned}$$

where S is stature, R is resistance, and the SEE = 3.24%.

Sex-specific reference points for BMI-for-age were obtained from the Centers for Disease Control and Prevention growth curves (16). For comparison with our study population, we defined overweight as a BMI-for-age above the 95th percentile and at risk of overweight as a BMI-for-age between the 85th and 95th percentiles (17). All computations, including descriptive statistics, were done by using SAS software (version 8; SAS Institute Inc, Cary, NC).

RESULTS

Of the 1705 children enrolled, complete measurements were obtained for 1704 (881 boys and 823 girls), and the data are presented in **Table 1**. The children's mean (±SD) age was 7.6 ± 0.6 y. Overall, 48.9% of the children were above the 85th percentile for BMI-for-age, and 28.6% were above the 95th percentile. The frequency distribution of percentage body fat by sex is presented in **Figure 1**. The 5th and 95th percentiles for percentage body fat in the total sample were 32.6% and 45.8%, respectively.

TABLE 2
Anthropometric characteristics of the children studied, by American Indian community[1]

	Age	Weight	Height	BMI	Skinfold thickness: Triceps	Skinfold thickness: Subscapular
	y	*kg*	*cm*	*kg/m²*	*mm*	
Boys						
White Mountain Apache (*n* = 152)	7.5 ± 0.6	32.5 ± 9.3	130.5 ± 5.6	18.9 ± 4.2	12.5 ± 6.8	9.9 ± 7.3
San Carlos Apache (*n* = 111)	7.6 ± 0.6	31.6 ± 8.5	130.0 ± 5.5	18.5 ± 3.7	12.0 ± 5.9	8.8 ± 6.2
Sicangu Lakota (*n* = 72)	7.8 ± 0.7	33.8 ± 9.9	131.7 ± 6.2	19.3 ± 4.2	11.8 ± 5.3	9.3 ± 5.8
Oglala Lakota (*n* = 158)	7.8 ± 0.7	33.4 ± 8.0	132.8 ± 6.4	18.8 ± 3.4	11.4 ± 4.5	8.9 ± 5.2
Navajo (*n* = 263)	7.4 ± 0.5	29.4 ± 7.3	126.9 ± 6.0	18.1 ± 3.4	11.6 ± 5.1	8.8 ± 6.2
Gila River, Pima-Maricopa (*n* = 44)	7.8 ± 0.7	34.0 ± 10.0	131.4 ± 5.8	19.4 ± 4.2	13.9 ± 6.7	10.2 ± 7.3
Tohono O'odham (*n* = 81)	7.8 ± 0.7	38.2 ± 11.9	133.7 ± 6.5	21.1 ± 4.9	15.3 ± 6.8	12.7 ± 8.1
All communities (*n* = 881)	7.6 ± 0.6	32.3 ± 9.1	130.2 ± 6.5	18.8 ± 3.9	12.2 ± 5.8	9.5 ± 6.6
Girls						
White Mountain Apache (*n* = 121)	7.5 ± 0.6	31.0 ± 7.3	129.9 ± 5.7	18.2 ± 2.9	13.4 ± 5.0	10.3 ± 5.8
San Carlos Apache (*n* = 94)	7.5 ± 0.5	31.9 ± 7.7	129.8 ± 5.5	18.8 ± 3.4	14.4 ± 5.2	11.11 ± 5.7
Sicangu Lakota (*n* = 65)	7.6 ± 0.6	32.8 ± 8.7	130.9 ± 5.7	18.9 ± 3.7	12.7 ± 4.3	10.0 ± 4.8
Oglala Lakota (*n* = 155)	7.7 ± 0.7	33.5 ± 8.8	131.3 ± 6.3	19.2 ± 3.8	13.3 ± 4.5	11.0 ± 5.7
Navajo (*n* = 273)	7.4 ± 0.6	29.1 ± 7.6	126.7 ± 5.4	18.0 ± 3.8	12.9 ± 4.6	10.3 ± 6.1
Gila River, Pima-Maricopa (*n* = 43)	7.6 ± 0.5	35.0 ± 8.4	130.1 ± 5.1	20.5 ± 4.1	17.0 ± 6.4	15.3 ± 7.9
Tohono O'odham (*n* = 72)	7.6 ± 0.6	36.6 ± 10.5	131.1 ± 6.4	21.0 ± 4.7	16.9 ± 5.9	14.2 ± 7.4
All communities (*n* = 823)	7.5 ± 0.8	31.8 ± 8.6	129.4 ± 6.0	18.8 ± 3.8	13.7 ± 5.1	11.1 ± 6.2

[1] $\bar{x}$ ± SD. Samples sizes vary slightly for each measurement as a result of missing values.

Average anthropometric data by American Indian community are presented in **Table 2**. The mean BMI in boys ranged from 18.1 to 21.1. The BMI range in girls was similarly narrow, from 18.0 to 21.0, reflecting the narrow age range of the sample.

Data on the percentage body fat and BMI cutoffs in each participating community are presented in **Table 3**. The percentage of children with a BMI above the 95th percentile ranged from 23.4% to 53.5% in girls and from 20.5% to 49.4% in boys. Although there was a considerable range across sites, in all cases the obesity prevalences were substantially higher than expected on the basis of reference data.

Seven children had a BMI below the 5th percentile, a proposed cutoff for defining undernutrition (18). This represents 0.4% of the sample population.

DISCUSSION

The high prevalence of overweight among American Indian children relative to the general population has been emphasized in several studies (4, 8, 19–25). Most of these studies sampled a relatively small number of children, however, usually from only one tribe or community. Our report represents the current prevalence of BMI-for-age above the 95th percentile in school-aged children attending 41 elementary schools in 7 American Indian communities. In addition, we present body-composition data that were collected with the use of a validated field method. Our data show that the prevalence of overweight in children from these communities is substantially higher than national levels. For example, in a reexamination of childhood obesity data from NHANES III, Troiano et al (2) reported a prevalence of overweight

TABLE 3
Percentage body fat and percentage of children between the 85th and 95th percentiles and above the 95th percentile for BMI[1]

	Percentage body fat: Girls	Percentage body fat: Boys	BMI between the 85th and 95th percentiles: Girls	BMI between the 85th and 95th percentiles: Boys	BMI > 95th percentile: Girls	BMI > 95th percentile: Boys
	%		%		%	
White Mountain Apache (*n* = 121 G, 152 B)	33.5 ± 6.0[2]	32.1 ± 7.4	20.7	14.5	24.8	29.6
San Carlos Apache (*n* = 94 G, 111 B)	33.9 ± 6.3	30.5 ± 6.7	28.7	20.7	26.6	22.5
Sicangu Lakota (*n* = 65 G, 72 B)	34.3 ± 5.6	33.0 ± 6.6	24.6	22.2	27.7	29.2
Oglala Lakota (*n* = 155 G, 158 B)	34.2 ± 6.1	31.3 ± 5.9	18.1	25.2	35.5	24.5
Navajo (*n* = 273 G, 263 B)	32.2 ± 6.3	29.9 ± 6.6	18.7	18.3	23.4	20.5
Gila River, Pima-Maricopa (*n* = 43 G, 44 B)	37.2 ± 7.3	31.9 ± 7.2	20.9	22.7	53.5	27.3
Tohono O'odham (*n* = 72 G, 81 B)	37.2 ± 7.6	35.1 ± 8.1	23.6	17.3	50.0	49.4
All communities (*n* = 823 G, 881 B)	33.8 ± 6.5	31.4 ± 7.0	21.0	19.6	30.5	26.8

[1] Percentage body fat was estimated by using an equation that included sex, age, weight, resistance, reactance, and triceps and subscapular skinfold thicknesses. BMI was compared with age-adjusted reference values from the 2000 Centers for Disease Control and Prevention growth charts. G, girls; B, boys.
[2] $\bar{x}$ ± SD.

(>95th BMI percentiles of NHANES) of 11% in children aged 6–11 y, compared with 28.6% in the present study. Triceps skinfold thickness, an index of body fatness, was notably higher in our sample than the reference values for 7-y-old children (26): median triceps skinfold thickness was 12.2 and 13.7 mm in boys and girls, respectively, compared with 8.59 and 10.68 cm, respectively, in the reference population (26).

Most published surveys on the BMI of American Indian children have not included specific measurement of body fatness. One reason for this is that there are no simple, inexpensive methods widely used for quantifying body adiposity in children, and there is also less consensus on how to use adiposity to define obesity in children of different ages. The use of BMI to assess excess weight in children has recognized limitations, despite being widely used. Because weight and height do not increase linearly nor in parallel throughout childhood, the same BMI value will reflect different body compositions at different ages (2). Beginning at around age 2 y, BMI tends to decline slightly, reflecting the predominant increase in height relative to weight, and increases again around age 5–6 y, a time when body fat accumulation increases progressively, a phase called adiposity rebound (27). These factors may lead to differing obesity prevalences calculated from the same database when BMI or other indexes of body adiposity are used (28, 29).

The relation between BMI and body fat in children may be affected by sex and maturation stage, resulting in a rapid increase in body fat accumulation at the onset of puberty in girls (30, 31). Our study did not measure sexual stage because the procedures were not culturally acceptable. For the purpose of the comparison between the control and intervention groups at the end of the study, it is expected that randomization will provide some assurance of the even distribution of maturation stages among study groups.

Our finding of 48.9% of children above the 85th percentile of BMI-for-age is higher than that reported in 1990 in a 5–18-y-old population (32). This may be due to differences in methodology, inclusion of a larger age span in the previous study, or to a secular trend toward higher body mass in American Indian children and adolescents. Such a trend toward higher BMI was documented by Sugarman et al (8) in Navajo children and adolescents, albeit over a longer time span. The tribe-specific results from our study document a common pattern of high prevalence of obesity in all 7 Indian communities. Although the overall prevalence of overweight was somewhat higher in girls than in boys (30.5% compared with 26.8%; Table 3), these sex differences were not consistent; in some communities, the prevalence of overweight was higher in boys and in some there was little difference between the sexes. Because our study design and sample size were not aimed at performing intertribe comparisons, no formal comparison was included in the data analysis.

Because the Pathways intervention targeted the whole 3rd-5th grade population at each school, regardless of BMI status, the possibility that the intervention could affect the rate of growth of nonoverweight children was also considered. Childhood undernutrition diarrheal diseases were important problems in this community only a few decades ago (33). Of the present cohort, only 7 children (0.4% of the sample) had a BMI below the 5th percentile (34). This is substantially less than the 85 expected on the basis of our sample size.

In summary, our results underscore the high prevalence of overweight in children from several of the major American Indian communities. Similarly, percentage body fat was higher than available reference values from all-race US populations of similar age. The fact that these differences are already evident in 2nd-grade children highlights the need to consider obesity prevention interventions for preschool-aged children in addition to programs targeting elementary schools.

We are indebted to the children, parents, and teachers who participated and helped in obtaining these data. We also recognize the continuing support of tribal, school, and health authorities at each of the sites of this survey. Stephanie Cano from the Pathway Coordinating Center provided expert statistical support for the preparation of the figure and tables.

All authors participated in the development of the study protocol and supervised its implementation and the data collection at the field sites. JS supervised the data analysis and BC wrote the manuscript, which was reviewed and approved by all authors. No author had a financial or personal conflict of interest related to this research or its source of funding.

REFERENCES

1. Troiano RP, Flegal KM. Overweight children and adolescents: description, epidemiology, and demographics. Pediatrics 1998;101:497–504.
2. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. JAMA 2002;288:1728–32.
3. Hill JO, Peters JC. Environmental contribution to the obesity epidemic. Science 1998;280:1371–4.
4. Broussard BA, Johnson A, Himes JH, et al. Prevalence of obesity in American Indians and Alaskan Natives. Am J Clin Nutr 1991;53(suppl):1535S–42S.
5. Byers T. The epidemic of obesity in American Indians. Am J Dis Child 1992;146:285–6.
6. Jackson MY. Height, weight, and body mass index of American Indian schoolchildren, 1990–91. J Am Diet Assoc 1993;93:1136–40.
7. Zephier E, Himes JH, Story M. Prevalence of overweight and obesity in American Indian school children and adolescents in the Aberdeen area: a population study. Int J Obes Relat Metab Disord 1999;23:S28–30.
8. Sugarman JR, White LL, Gilbert TJ. Evidence for a secular change in obesity, height, and weight among Navajo Indian schoolchildren. Am J Clin Nutr 1990;52:960–6.
9. Nelson DM. Height and weight changes among White Mountain Apache children. The IHS Provider 1994;4:50–5.
10. Flegal KM. Defining obesity in children and adolescents: epidemiologic approaches. Crit Rev Food Sci Nutr 1993;33:307–12.
11. Caballero B, Davis CE, Evans MD, et al. Pathways: a school-based program for the primary prevention of obesity in American Indian children. J Nutr Biochem 1998;9:535–43.
12. Davis CE, Hunsberger S, Murray DM, et al. Design and statistical analysis for the Pathways study. Am J Clin Nutr 1999;69(suppl):760S–3S.
13. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Champaign, IL: Human Kinetics Publishers, 1988.
14. Houtkooper L, Going SB, Lohman TG, Roche AF, Van Loan M. Bioelectrical impedance estimation of fat-free body mass in children and youth: a cross-validation study. J Appl Physiol 1992;72:366–73.
15. Lohman TG, Caballero B, Himes JH, et al. Estimation of body fat from anthropometry and bioelectrical impedance in Native American children. Int J Obes Relat Metab Disord 2000;24:1–7.
16. Centers for Disease Control and Prevention. 2000 CDC growth charts. Internet: http://www.cdc.gov/growthcharts (accessed 20 December 2002).
17. Himes JH, Dietz WH. Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. Am J Clin Nutr 1994;59:307–16.

18. WHO Expert Committee. Physical status: the use and interpretation of anthropometry. World Health Organ Tech Rep Ser 1995;854.
19. Harrison GG, Ritenbaugh CK. Obesity among North American Indians. In: Bjortorp P, Brodoff BN, eds. Obesity. Philadelphia: JB Lippincott Co, 1992:610–8.
20. Gilbert TJ, Percy CA, Sugarman JR, Benson L, Percy C. Obesity among Navajo adolescents. Relationship to dietary intake and blood pressure. Am J Dis Child 1992;146:289–95.
21. Abbott WGH, Foley JE. Comparison of body composition, adipocyte size, and glucose and insulin concentrations in Pima Indian and Caucasian children. Metabolism 1987;36:576–9.
22. Gruber E, Anderson MM, Ponton L, DiClemente R. Overweight and obesity in Native-American adolescents: comparing nonreservation youths with African-American and Caucasian peers. Am J Prev Med 1999;11:306–10.
23. Gallaher MM, Hauck FR, Yang-Oshida M, Serdula MK. Obesity among Mescalero preschool children. Am J Dis Child 1991;145:1262–5.
24. Story M, Tompkins RA, Bass MA, Wakefield LM. Anthropometric measurements and dietary intakes of Cherokee Indian teenagers in North Carolina. J Am Diet Assoc 1986;86:1555–60.
25. Strauss KF. American Indian school children height and weight survey. The IHS Provider 1993;18:137–42.
26. Must A, Dallal GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht^2) and triceps skinfold thickness. Am J Clin Nutr 1991;53:839–46.
27. Rolland-Cachera M-F, Deheeger M, Bellisle F, Guilloud-Bataille M, Patois F. Adiposity rebound in children: a simple indicator for predicting obesity. Am J Clin Nutr 1984;39:129–35.
28. Gortmaker SL, Dietz WH, Sobol AM, Wehler CA. Increasing pediatric obesity in the United States. Am J Dis Child 1987;141:535–40.
29. Harlan WR, Landis JR, Flegal KM, Davis CS, Miller ME. Secular trends in body mass in the United States, 1960–1980. Am J Epidemiol 1988;128:1065–74.
30. Beunen G, Malina RM, Lefevre JA, Claessens AL, Renson R, Vanreusel B. Adiposity and biological maturity in girls. Int J Obes Relat Metab Disord 1994;18:542–6.
31. Morrison JA, Barton B, Biro F, Sprecher DL, Falkner F, Obarzanek E. Sexual maturation and obesity in 9- and 10-year-old black and white girls: The National Heart, Lung, and Blood Institute Growth and Health Study. J Pediatr 1994;124:889–95.
32. Jackson MY. Nutrition in American Indian health: past, present and future. J Am Diet Assoc 1986;86:1561–4.
33. Owen GM, Garry PJ, Seymoure RD, Harrison GG, Acosta PB. Nutrition studies with White Mountain Apache preschool children in 1976 and 1969. Am J Clin Nutr 1981;34:266–77.
34. de Onis M, Habicht JP. Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. Am J Clin Nutr 1996;64:650–8.