Blood Pressure and Body Measurements among Navajo Adolescents

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SYNOPSIS

WE ASSESSED THE PREVALENCE of obesity, high normal blood pressure (BP), and the relationship between BP and anthropometric measurements in a sample of Navajo adolescents. The prevalence of obesity in boys and girls was 3 times that expected in U.S. white adolescents of the same age (17.1% for boys, 15.9% for girls) using body mass index as a criterion. The prevalence of high normal BP (between the 90th and 95th percentiles) was nearly twice that expected by definition (8.7% for boys and 9.1% for girls).

Although systolic blood pressure (SBP) and diastolic blood pressure (DBP) increased significantly with age for boys and not for girls, SBP and DBP increased significantly with increasing body mass for both boys and girls. Given the high prevalence of obesity and the observed association with BP, primary prevention of hypertension among the Navajo should emphasize maintaining a healthy body weight at early ages.

The relationship between body composition and blood pressure (BP) among young children and adolescents is of great public health concern, particularly since elevated BP in young children or adolescents can precede adult hypertension. Increasing body fatness is positively associated with BP and other cardiovascular disease (CVD) risk factors in children and adolescents *(1–3)*. Among the Navajo, one of the largest Indian tribes in North America, the prevalence of overweight and obesity in schoolchildren and adolescents has been reported to be higher than in the general population *(4,5)*. However, few data exist that describe other CVD risk factors among Navajo children and adolescents. In this report, we assess the proportion of Navajo adolescents with high normal BP, and examine the relationship between BP and anthropometric measurements in a sample of Navajo adolescents.

Methods

Information from two separate studies was combined for the present analysis. The first was a school-based survey in the Northeastern corner of the Navajo Indian Reservation conducted from 1989 to 1991. Details of the study design have been described elsewhere *(5)*. Briefly, four secondary

Table 1. Blood pressure and body measurements for Navajo adolescent boys and girls ages 13 to 18

	Boys (n=225)		Girls (n=256)			
	Mean	$s_{\bar{x}}$	Mean	$s_{\bar{x}}$	t	Two-sided P
Age (yrs)	16	0.10	16	0.08	−1.53	NS[a]
Systolic BP (mmHg)	112.8	0.80	105.8	0.68	6.77	<.001
Diastolic BP (mmHg)	67.4	0.65	63.9	0.58	4.0	<.001
Height (cm)	170.1	0.44	160.2	0.35	17.8	<.001
Weight (kg)	66.6	0.92	62.6	0.93	3.1	<.05
Body Mass Index	23.0	0.28	24.2	0.31	−2.9	<.05
Subscapular SF (mm)	18.9	0.79	22.4	0.60	−3.9	<.001
Triceps SF (mm)	14.5	0.51	21.1	0.46	−9.6	<.001
Subscapular-Triceps Ratio	1.4	0.40	1.1	0.02	<.001	
Percent Obesity[b]	17.1%		15.1%			
Percent High Normal BP[c]	8.7%		9.1%			

[a] NS indicates not significant.
[b] 95th percentile for BMI (ref 8).
[c] Between the 90th and 95th percentiles for systolic and(or) diastolic BP (ref 7).

Table 2. Mean (±s) systolic and diastolic blood pressure and body mass index for Navajo boys and girls ages 13 to 18

		Systolic Blood Pressure		Diastolic Blood Pressure		Body Mass Index	
Age	n	Mean	s	Mean	s	Mean	s
Boys							
13	11	103	13	64	8	22	5
14	12	107	6	65	9	25	5
15	50	111	12	64	9	22	5
16	45	112	11	68	10	23	4
17	50	117	11	69	8	23	3
18	50	115	11	70	9	23	4
Girls							
13	6	108	11	60	5	24	5
14	11	101	10	67	8	24	6
15	44	108	10	65	8	24	5
16	59	106	10	65	8	24	4
17	55	105	11	63	9	24	5
18	54	106	9	63	10	25	6

schools located in different parts of the reservation participated in a survey to assess body weight, blood pressure, and dietary practices of Navajo adolescents.

The second data set resulted from a large reservation-wide, population-based study of the prevalence of selected chronic diseases and related risk factors among adolescents and adults carried out from 1990 to 1992 *(6)*. The latter study included interviews conducted in homes randomly selected through a multistage probability sampling strategy.

Interviewers used the same protocols and instruments for BP and anthropometric measurements in both studies. They measured height, weight, and triceps and subscapular skinfold (SF) following established protocols. The formula to calculate body mass index (BMI) was weight in kilograms divided by height in meters squared. The subscapular/triceps SF ratio was calculated as an indicator of body fat distribution.

BP measurement protocols included 1) using a random-zero sphygmomanometer and an appropriate cuff size, 2) having participants rest for at least 10 minutes before measurement, and 3) taking the average of two measurements for both systolic blood pressure (SBP) and diastolic blood pressure (DBP) for use in these analyses.

To assess differences in BP and anthropometric measurements between boys and girls, we used unpaired t-tests. We compared mean values of BP with those of white adolescents from the Second National Health and Nutrition Examination Survey (NHANES II) and used recommended BP cutoff values *(7)* to assess the proportion of boys and girls with high normal BP (between the 90th and 95th percentiles). The prevalence of obesity was defined as the proportion of boys and girls with BMIs greater than the 95th percentile of the white reference population *(8)*.

To determine if BP increased with increasing body mass, we created quartiles of BMI for boys and girls separately and used one-way analysis of variance to assess differences in SBP and DBP by BMI quartiles. We used least squares multiple linear regression (stepwise method) to assess the influence of age, weight, height, BMI, triceps SF, subscapular SF, and subscapular-triceps SF ratio on the dependent variables SBP and DBP *(9)*.

Results

Information was available for 481 subjects (225 boys, 256 girls) ages 13 to 18. As shown in Table 1, there were significant differences for BPs and all body measurements between boys and girls. Mean values of SBP and DBP for Navajo adolescents were below those of white adolescents in NHANES II at all ages (data not shown). A slightly greater proportion of boys (17.1%) than girls (15.9%) were obese, and little difference was noted between the proportion of boys (8.7%) and girls (9.1%) with high normal BP. No subjects in our study had BP values above the 95th percentile.

Table 2 presents mean (±s) SBP, DBP, and BMI for boys and girls. SBP and DBP increased significantly with increasing quartiles of BMI for both boys and girls (data not shown). Stepwise linear regression showed that for boys, 21.7% of the variance in SBP was accounted for by variation (in order of entry) in weight, subscapular-triceps SF ratio, and age. Variation in weight accounted for 6.7% of the variance in DBP. For girls, variation in weight accounted for 19% of the variance in SBP, and 10.4% of the variance in DBP was accounted for by variation in BMI and age.

Discussion

We found that the prevalence of obesity among Navajo adolescents was three times that expected among U.S. white adolescents (for example, 5% would be expected to be above the BMI 95th percentile), and that mean BP increased with increasing body mass for boys and girls. The proportion of boys and girls with high normal BP was also greater than the 5% expected. From a study of BP among Navajo adolescents completed 10 years previously, Coulehan and colleagues reported greater mean values of SBP and DBP than those reported in the present study *(10)*. Furthermore, the proportion of adolescents with elevated BP (SBP ≥140 and(or) DBP ≥90) was greater for boys (11.1%) but not for girls (1.6%). Differences in study design, sampling frame, and measurement of BP may account for the discrepancies between the two studies.

There are limitations to the present study that should be considered when interpreting results. First, the number of subjects is small and BP measurements were collected at one point in time; that is, no follow-up measurements were made for adolescents with high normal readings on the initial screening. The small number of subjects could have limited the ability to predict SBP and DBP with linear regression techniques. Second, because growth and development during adolescence are dynamic, it is difficult to disentangle the influences of age and body composition on blood pressure. Furthermore, we had no information to control for sexual maturity in our study.

In summary, our study suggests that although mean levels of SBP and DBP are below those of white adolescents in the general U.S. population, BP increases with increasing body mass among Navajo adolescents. Primary prevention of adult hypertension among Navajo communities should include targeting youth at highest risk (for example, family history of hypertension, diabetes, and(or) obesity) and emphasize maintenance of a healthy body weight at early ages.

References

1. Gutin, B., and others: Blood pressure, fitness, and fatness in 5- and 6-year old children. JAMA 264: 1123–1127 (1990).
2. Staessen, J., Fagard, R., Lijnen, P., and Amery, A.: Body weight, sodium intake and blood pressure. J Hypertens 7: (Supp. 1) S19–S23, February 1989.
3. Williams, D. P., and others: Body fatness and risk for elevated blood pressure, total cholesterol, and serum lipoprotein ratios in children and adolescents. Am J Public Health 82: 358–363 (1992).
4. Sugarman, J. R., White, L., and Gilbert, T. J.: Evidence for a secular change in obesity, height and weight among Navajo Indian school children. Am J Clin Nutr 52: 960–966 (1990).
5. Gilbert, T. J., and others: Obesity among Navajo adolescents: relationship to dietary intake and blood pressure. Am J Dis Child 146: 289–295 (1992).
6. White, L. L., and Gilbert, T. J.: Navajo health and nutrition survey training and protocol manual. Indian Health Service, Window Rock, AZ.
7. Task Force on Blood Pressure Control in Children. Report of the second task force on blood pressure control in children—1987. Pediatrics 79: 1–27 (1987).
8. Must, A., Dallal, G. E., and Dietz, W.: Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht5) and triceps skinfold thickness. Am J Clin Nutr 53: 839–846 (1991).
9. SPSS for Windows, version 6.0. SPSS, Inc., Chicago, IL.
10. Coulehan, J. L., Topper, M. D., Arena, V. C., and Welty, T. K.: Determinants of blood pressure in Navajo adolescents. Am Ind Alas Native Ment Health Res 3: 27–36 (1990).