DETERMINANTS OF BLOOD PRESSURE IN NAVAJO ADOLESCENTS

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Abstract: Hypertension is becoming more common among Navajo people, especially among young men. In a group of 580 Navajo adolescents, we looked for factors associated with variations in blood pressure level. Using our criteria, 11.1% of adolescent males and 1.6% of females had an elevated screening blood pressure. In males, blood pressure was a function of age only, and not significantly related either to obesity (body mass index) or measures of acculturation and personal adjustment. In females, blood pressure was not related to age, but was associated with body mass index. Systolic pressure in females was also associated with poor personal adjustment. Level of acculturation (by our index) had no bearing on blood pressure level in this population.

The low prevalence of ischemic heart disease among the Navajo and other Southwestern American Indians has been a striking and consistent finding in studies over the last 50 years (Gilbert, 1955; Sievers, 1967; Smith, 1957; Hesse, 1964; Fulmer & Roberts, 1963; Coulehan, Lerner, Helzlsouer, Welty, & McLaughlin, 1986; Coulehan, in press). While the incidence of acute myocardial infarction is increasing (Klain, Coulehan, Arena, & Janett, 1988; Sievers & Fisher, 1979), age-adjusted mortality from ischemic heart disease among Navajo people in 1981-1983 was less than one-third that of American Indians in general, and less than one-fourth that of the U.S. population as a whole (Coulehan, in press). In an effort to understand this resistance to heart disease, investigators have studied the prevalence of cardiovascular risk factors, such as smoking, diabetes, elevated serum cholesterol, and hypertension.

Hypertension was uncommon in early clinical studies and surveys (Coulehan, in press). For example, Fulmer and Roberts (1963) found in the late 1950s a prevalence of only 4% among the adult Navajo population in a community survey of Many Farms. However, more recent evidence, some of which was summarized by Sievers in 1979, suggests that the prevalence of high blood pressure has been increasing among Southwestern Indians. Twenty years after Fulmer's study, we screened several hundred adult Navajo volunteers and found that 17% had abnormally high casual blood pressures (DeStefano, Coulehan, & Wiant, 1979).

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When we looked in some detail at the results of this screening program, we found that elevated blood pressures were quite common in young men, and did not appear to increase with age, as is the usual pattern in the United States and Europe. However, there was a dramatic difference between young men and young women in the occurrence of elevated blood pressure. This pattern led us to hypothesize that hypertension was increasing among the Navajo primarily because of excess cases among the younger male population (DeStefano et al., 1979). If this were true, one would expect to see more dramatic increases in hypertension as this cohort of persons aged and new cohorts were exposed to whatever factors were contributing to the elevated blood pressures.

What might these factors be? Observers have advanced two sets of hypotheses to explain the low prevalence of hypertension in traditional societies (Eyer, 1975). The first is that these societies are generally characterized by adequate exercise, little obesity, and diets that typically have a low salt content. The second set of hypotheses is concerned with the "coherent value systems" of traditional societies. Because there is little personal or social stress in such societies, the chronic adrenergic stimulus that causes blood pressure elevation does not occur.

When traditional cultures adopt Western values and lifestyles, the prevalence of hypertension increases. This could result from behavioral and dietary changes, leading to more obesity and higher salt intake; and/or it could result from the process of "acculturation" in which traditional economic, social, and cultural systems become disrupted and fragmented. Since we noted a high prevalence of elevated pressures among Navajo men aged 20 to 29 years, we assumed that pressure elevations started in adolescence. Therefore, we decided to survey an adolescent Navajo population to test the hypotheses that variations in blood pressure are related to some measure of body weight and obesity, and/or to some measure of acculturation or personal adjustment.

Methods

We conducted the study during 1981 in two Bureau of Indian Affairs dormitories for Navajo high school students in Tuba City and Flagstaff, Arizona. In each setting, we screened students during a one week period and were able to obtain blood pressure data on 580 adolescents 12 to 20 years of age, about 90% of the students residing in the two dormitories.

In the first part of data collection, two medical students and two community health personnel measured blood pressures, heights, and weights of each student. They took right brachial blood pressures in the sitting position using standard sphygnomanometers. The second part of data collection consisted of a 63 item questionnaire administered to students by dormitory counselors. Five hundred sixty nine (98%) of students completed the questionnaires, although in some cases questions were left

unanswered. Each student was assigned a unique study number so that confidentiality could be maintained.

Two subsets of questionnaire items were pertinent to the blood pressure study. First, 16 items dealt with the variable of traditionality and acculturation. These questions, and those for the other scale, were constructed by Dr. Topper based on extensive experience with Navajo culture and earlier studies of traditional Navajo family life, delayed adolescent separation-individuation, alcoholism, and depression among Navajo people (Topper & Curtis, 1987). The Appendix lists items used in the two scales. Questions in the acculturation scale included language spoken at home, type and location of the student's home, religion practiced by the student and his/her parents, and source of family income. A second scale containing 20 questions addressed the variable of personal adjustment rather than background cultural characteristics. Half of the questions dealt with whether or not the student had difficulties in school or delinquent behaviors. The other half dealt with the student's own feelings, such as degree of loneliness, anger and trust.

For purposes of the study, we defined "abnormal" screening blood pressure to be any determination in which the systolic pressure was 140 mmHg or greater, or in which the diastolic pressure was 90 mmHg or greater. This definition was similar to that used by the National Health and Nutrition Examination Survey (HANES I) for the adolescent age group (*Blood Pressure Levels*, 1977). We calculated body mass index (BMI) from measured height and weight. This index is defined as weight in kilograms divided by the square of the height in meters. A BMI of 27.8 in young males and of 27.3 in females is at the 85th percentile of 20 to 29 year old persons surveyed in HANES I, and values above those were considered to represent an overweight or obese condition (*Blood Pressure Levels*, 1977).

Responses to the adjustment and acculturation scales were assigned weighted values, and cumulative scores were calculated in each scale for each student. We performed continuity-corrected χ^2 tests to ascertain the presence of associations between elevated blood pressure and other discontinuous variables (e.g., responses to individual questions). To ascertain relationships among continuous variables (actual blood pressure, age, BMI and questionnaire scores), we performed a series of step-wise linear regression analyses.

Results And Discussion

Table 1 illustrates mean systolic and diastolic pressures by age and sex in this group of Navajo adolescents, comparing them with mean pressures from adolescents in the HANES I survey. As can be seen, both systolic and diastolic blood pressures increase with age in males, while a similar trend is not present among females. In general, systolic blood pressures of Navajo males were a little higher and diastolic pressures a little lower than the national sample. Using an identical definition of "abnormal,"

we found Navajo adolescent males were somewhat more likely to have elevated pressures than were males in HANES I (11.1% vs. 8.5%), and Navajo females were considerably less likely to have elevated pressures (1.6% vs. 4.2%). These percentages are, however, based on small numbers, as there were a total of 33 males and 4 females who met criteria for "abnormal" blood pressure.

Table 1
Blood Pressures of Navajo Adolescents Compared with Those of U.S. Adolescents (HANES I)

	Male (N=284)				Female (N=296)			
	Systolic		Diastolic		Systolic		Diastolic	
Age	Navajo	HANES	Navajo	HANES	Navajo	HANES	Navajo	HANES
13	112.6	111.3	64.1	69.5	115.2	111.4	67.9	68.4
14	116.5	111.4	66.3	68.6	116.1	112.8	67.4	68.3
15	124.4	116.4	68.4	71.4	113.7	111.7	67.7	69.7
16	121.6	119.1	67.7	72.8	114.5	113.6	69.4	69.4
17	124.8	119.5	72.4	73.7	112.9	112.2	66.9	71.2
18	126.2	123.5	72.5	76.3	113.5	114.8	69.3	71.5

Table 2 shows weight by gender and age group. Here, as one might expect, there is a progressive increase in mean weight with age among the males, but much less of an increase among females. Table 3 shows the percentage of adolescents in this study who attained or exceeded the 75th and 90th percentiles for weight derived from adolescents in the HANES I and other National Center for Health Statistics (NCHS) surveys. While 25% would be expected to exceed the 75th percentile, only 4.6% of males and 16.9% of females did so. Only about 2% of either sex exceeded the 90th percentile for weight. Even fewer Navajos exceeded these percentiles for height. The bottom row of Table 3 shows the percent of students overweight on the basis of calculated BMI. Using our cut-off points, one would expect about 15% to be considered overweight, while only 1.4% of males and 5.5% of females in this study met that criterion. Thus, despite the clinical impression of increasing rates of obesity among Navajos in general, little evidence of overweight was present in this adolescent group.

Table 2
Navajo Adolescents - Weight in Pounds by Gender and Age

Age	Male N.	Male X±(S.D.)		Female N.	Female x±(S.D.)	
13	19	106.9	(17.4)	27	112.6	(19.5)
14	32	114.1	(16.4)	32	119.9	(13.0)
15	47	122.1	(16.0)	55	120.8	(12.6)
16	55	132.1	(17.1)	49	124.5	(17.0)
17	58	136.6	(17.6)	55	123.5	(13.2)
18+	73	138.2	(15.8)	78	123.4	(14.3)

Table 3
Weight and Height of Navajo Adolescents
Compared to NCHS Percentiles

	Male (284)		Female (296)	
NCHS Percentiles	75	90	75	90
Weight	4.6%	2.1%	16.9%	2.0%
Height	3.2%	0.2%	4.1%	2.1%
Overweight (BMI*)	1.4%		5.5%	

*BMI ≥ 27.8 IF male; ≥ 27.3 if female.

On our acculturation scale, the median score was 15 (range 0-42) of a possible 50 points (fully acculturated), suggesting this student population was relatively unacculturated. The median score was 6 (range 0-32) of a possible 50 points on the adjustment scale. In this case, the lower end of the scale indicates good personal adjustment. Table 4 presents results of step wise linear regression analyses for age, BMI, acculturation, and adjustment scores. In these analyses, we employed actual blood pressures, rather than using the "normal/abnormal" dichotomy. In females, body mass index (BMI) was the most significant factor correlated with both systolic and diastolic blood pressure. In other words, increments in blood pressure were associated with increments in weight, but were not related to age. However, adjustment score also entered into the equation for systolic blood pressure in a negative manner; in other words, the less well adjusted girls had higher systolic blood pressures. For males, the only significant explanatory variable was age; blood pressure tended to increase with age but was not related to BMI or to either of the two calculated scores. "R^2" represents the proportion of all variation in blood pressure accounted for by the variables we studied. Only about 10% or so of blood pressure difference is explained.

Table 4
Results of the Stepwise Linear Regression Analysis of Gender, Body Mass Index, Age, Adjustment Score, and Acculturation Score on Blood Pressure

		Systolic Coeff.	p-value		Diastolic Coeff.	p-value
Total		(n=303)				
	Sex	-7.99	.0000	Age	.90	.0035
	BMI	.98	.0001	BMI	.61	.0092
		R^2=.15			R^2=.06	
Females+		(n=143)				
	BMI	1.04	.0002	BMI	.87	.0010
	Adjust.	.39	.0139			
		R^2=.10			R^2=.07	
Males+		(n=160)				
	Age	2.42	.0000	Age	2.04	.0001
		R^2=.14			R^2=.11	

+The covariate of gender was not used in these models.

For males, we looked at responses to individual questions, comparing those who had abnormally high screening pressures with those who had normal pressures (Table 5). Out of 46 such comparisons, two were significant and three others were of marginal significance. These findings are roughly what one would expect by chance alone and should, therefore, not be overinterpreted. However, they may suggest directions for future research. For example, a higher percentage of those with elevated blood pressure admitted to regularly drinking alcohol. This is consistent with our earlier finding that alcohol use was highly correlated with blood pressure in adult Navajo males (DeStefano et al., 1979). Kunitz and Levy, in a survey of elderly (aged 65 years and over) Navajos, found that alcohol use was correlated with hypertension in females but not in males (Kunitz & Levy, 1986). However, this observation was based on a very small number of women who admitted to drinking (5 out of 135) and the lack of correlation in men was based on a high percentage of men whose drinking status was "unknown" (41 out of 134). Alcohol usage was correlated with hypertension in several major investigations, such as the Kaiser Permanente study in which taking three or more drinks per day was highly correlated with elevated blood pressure, independent of age, gender and a number of other variables (Klatsky, Friedman, Siegelaub, & Gerard, 1977). It is a

reasonable hypothesis that widespread use of alcohol might be associated with the increasing prevalence of hypertension among Navajo people.

Table 5
Responses to Selected Questions by Screening Blood Pressure Status - Males Only (N=284)

Question	Blood Pressure Elevated	Blood Pressure Not Elevated	χ^2	df	p
Regularly drink alcohol	69%	49%	5.99	2	0.05
Participate in school sports activities	46%	35%	3.26	1	0.07
Feel lonely - three or more times weekly	33%	11%	10.77	3	0.01
Feel angry - once a week or more	16%	5%	8.31	4	0.08
Religion different from parents religion	4%	22%	3.07	1	0.08

Two items about perceived emotional states--feeling lonely and feeling angry--appeared to be correlated with elevated blood pressure in males. While these may be chance findings, the associations do suggest that perhaps it is not cultural or lifestyle changes per se that influence blood pressure, but emotional response to them. If response induces a sustained hyperadrenergic state, elevated systolic and diastolic blood pressures might develop.

Our study has a number of serious limitations. It suffers from small sample size, yielding few subjects with truely elevated pressures. A single casual blood pressure determination has obvious limitations as an endpoint. Students living in the two dormitories may not be typical of all adolescent Navajos. These students were likely to have homes located at some distance from any settlement or school, which suggests that they came from a less acculturated background than similarly-aged students who lived in towns. The low median scores on our acculturation scale provide some support for this hypothesis. Our two scales were devised for this study and were not validated in other groups. In retrospect, the acculturation scale may well measure traditionality or ethnic identification rather than the process of acculturation *per se*. Low scores came from families with a traditional life style. Such persons may be less acculturated, but the scale does not directly measure that process. A strong point of the study, however, is that we were able to survey a high percentage (over 90%) of the students in target dormitories.

Two other studies of blood pressure in childhood or adolescence are relevant to this report. In the Bogalusa Heart Study, blood pressures

of children aged 5 to 14 years were found be be correlated with height, weight/height, and skin fold thickness (the latter two being indices of obesity), but were not found to be independently correlated with age (Voors, Webber, Frerichs, & Berenson, 1977). Gender was not entered into the equation and its effect on these relationships is unknown. This study indicates that even in childhood, weight/height indices are important predictors of blood pressure.

In the Tacoma Study, the relationship of various behavioral parameters to blood pressure in adolescents was examined (Siegel & Leitch, 1981). Those who had elevated pressures differed from the others in terms of life dissatisfaction, impatience, "type A" behavior patterns, anger, and hostility. However, the latter three associations vanished when controlled for an index of obesity (Quetelet's index). Life events were not correlated with blood pressure. Again, relative weight seemed to be the most important variable studied, although life dissatisfaction and impatience (factors perhaps related to our adjustment scale) were independently correlated with pressure (Siegel & Leitch, 1981).

Conclusion

In conclusion, we found that 1) elevated blood pressures are more frequent in male Navajo adolescents than in females; 2) blood pressures increase with age in males, but not in females; 3) pressures are independently related to weight in females, but not in males; 4) poor personal adjustment may be associated with higher systolic pressure in females; and 5) traditionality as measured by our "acculturation" scale was unrelated to blood pressure in this adolescent group.

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APPENDIX 1
Items Used to Assess Acculturation and Personal Adjustment.

Acculturation

1. Languages spoken by mother
2. Languages spoken by father
3. Language spoken to parents
4. Proximity of grandparents
5. Structure of home
6. Utilities in home
7. Family source of income
8. Location of home
9. Number of siblings
10. Presence of livestock
11. Parents' religion
12. Personal religion
13. Religion different from parent's
14. Traditional healing for immediate family (in last year)
15. Traditional healing for extended family (in last year)
16. Pacement in Anglo foster home

Personal Adjustment

1. School performance
2. Cut classes
3. Suspension from school
4. Arrests
5. Referred to school counselor
6. Use of alcohol
7. Use of marijuana
8. Sniff glue or paint
9. Use of pills
10. Sports participation
11. Insomnia
12. Loss of appetite
13. School goals
14. Trust others
15. Loneliness
16. Nervousness
17. Wake up sweating
18. Nightmares
19. Anger
20. Interest in school