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Relationship of Blood Pressures with Hair Mineral Concentrations in South Carolina Adolescents

Denis M. Medeiros[1] and Robert F. Borgman[2]

Department of Food Science, Clemson University, Clemson, SC 29631

Many years South Carolina has the highest cardiovascular disease rate in the nation (PERRY and PERRY 1974). Hypertension is a confirmed risk factor for the onset of this disease.

Formerly, hypertension was considered an adult disease (ADELMAN 1978). LOGGIE (1971) stated that hypertension in adolescents has been overlooked by physicians because the systolic pressures do not approach those found in hypertensive adults. He suggested that systolic pressures in the 95th percentile (above 130 mmHg) be looked upon with suspicion in adolescents. LAUER et al. (1976) defined adolescent hypertension as a diastolic pressure of 90 mmHg or greater.

Cadmium and other minerals have been implicated in the development of hypertension. SCHROEDER (1965) demonstrated that renal cadmium concentrations were significantly greater in subjects dying from hypertensive complications than in those dying of accidents or atherosclerotic heart disease. RUDOLPH (1978) used hair as an indicator of mineral status and found that hypertensives had higher hair cadmium concentrations and lower sodium concentrations. In contrast, DALLY et al. (1978) found no difference in blood cadmium concentrations between hypertensives and normotensives. BORGMAN et al. (1982) noted a positive association between hair concentrations of lead, selenium, copper, and chromium of South Carolina adolescents to percent hypertension in their home counties. The same study found an increased incidence of hypertension in adolescents from the coastal portion of South Carolina (8-10%) as compared to adolescents from the upstate area (1-2%).

The objectives of the present study were to examine the relationships of hair mineral concentrations to blood pressures in adolescents from the coastal portion of South Carolina.

[1] Present address: Drawer HE, Mississippi State University, Mississippi State, MS 39762

[2] To whom reprints should be addressed

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MATERIALS AND METHODS

The study was conducted at 4-H Camp Bob Cooper in Manning, S.C., which serves adolescents from the coastal counties, during the summers of 1978, 1979, and 1980. A parental consent form was required of each participant.

Adolescents studied ranged in age from 9 to 14 yrs. Blood pressure was recorded from the right arm in the sitting position with an electronic blood pressure instrument capable of measurements to 2 mmHg (Clark International Inc., Milwaukee, Wis.). One or two emergency medical technicians measured blood pressures at tables separated from external influences. Adolescents with a systolic pressure greater than 129 mmHg and/or a diastolic pressure greater than 89 mmHg were considered hypertensive. Potential hypertensives were rechecked the following day.

Controls matched to the hypertensives for sex and race had their blood pressures recorded. Hypertensives and controls had hair samples removed from the nape of the neck by using stainless steel scissors. Scissors were washed between uses in 95% ethanol. Hair samples were stored in envelopes and returned to the lab for mineral analysis. In most cases, hair samples weighed 0.1 to 0.2 g.

Hair samples were prepared for mineral analysis by atomic absorption spectrophotometry. The preparation required hair washing and digestion-ashing. All chemical reagents were purchased from Fisher Scientific Co., Fair Lawn, New Jersey.

All rinsings in the hair washing procedure used distilled deionized water. Hair samples were placed on moistened Whatman filter paper number 1 in a Buchner funnel. About 50 mL of water was added to the hair sample and drained. Fifty milliliters of 1% sodium lauryl sulfate was added to the sample and drained. Suction was applied to remove suds. Two rinses with about 50 mL water followed. The remaining water was removed by suction. Hair samples were dried in a vacuum oven with 30 mmHg at 30°C until dry (about 48 hr).

Weighed hair samples were placed in a glass beaker and digested and ashed in 5 mL of reagent ACS nitric acid (69-71%) and 1 mL of 70% perchloric acid (HORWITZ 1980). Samples were diluted up to 10 mL with water and stored in Nalgene plastic bottles (Nalge Co., Rochester, N.Y.). For calcium and magnesium analysis, a 0.25% $SrCl_2$ solution was used as a diluting medium (DINNIN 1960).

An atomic absorption spectrophotometer (Hitachi 170-50 AAS, Hitachi Corporation, Tokyo, Japan) was used for mineral analysis. Flame was used to analyze for Ca, Mg, Zn, and Fe. A graphite furnace (Hitachi GA-2 Graphite Atomizer, Tokyo, Japan) was used to analyze for Cu, Cd, Pb, Cr, and Ni.

Standards were prepared from Certified Atomic Absorption standards. Proper background corrections were made. Hair mineral data was expressed as parts per million (ppm).

Blood pressure differences by sex and race were calculated by analysis of variance. Hair mineral data were fitted to linear, quadratic, cubic, or quartic expressions for best fit (STEEL and TORRIE 1980).

RESULTS

In each year of the study, there were slightly more males than females (Table I). Blacks and whites were present in approximately equal proportions for 1979. For 1980, there was a larger number of whites than blacks present. Black females had significantly ($p \leq 0.05$) greater diastolic blood pressures than white males.

TABLE I

Mean blood pressures by sex-race and year in South Carolina adolescents*.

Year	Class	N	Systolic	Diastolic	Pulse
1979	Black Female	38	112	69	43
	White Female	37	114	70	44
	Black Male	44	116	69	46
	White Male	54	116	67	49
1980	Black Female	29	116	68a	47
	White Female	49	112	62bc	50
	Black Male	39	115	65ab	50
	White Male	62	112	60c	52

* Means with different letters are statistically different ($p \leq 0.05$) within each year. Duncan's Multiple Range test used for sex-race differences.

Significant R^2 ($p \leq 0.05$) presented represent the equation for best fit (N=162). Higher hair zinc concentrations were associated with lower pulse pressures (Figure 1). Higher hair copper concentrations were associated with higher systolic pressures. Higher hair nickel was associated with lower systolic and pulse pressures. Hair cadmium concentrations were related to lower systolic and diastolic pressures. Higher lead concentrations were associated with higher systolic pressures and slightly lower diastolic pressures. Higher copper to zinc ratios were associated with slightly greater systolic and pulse pressures. In all cases, R^2 values were low.

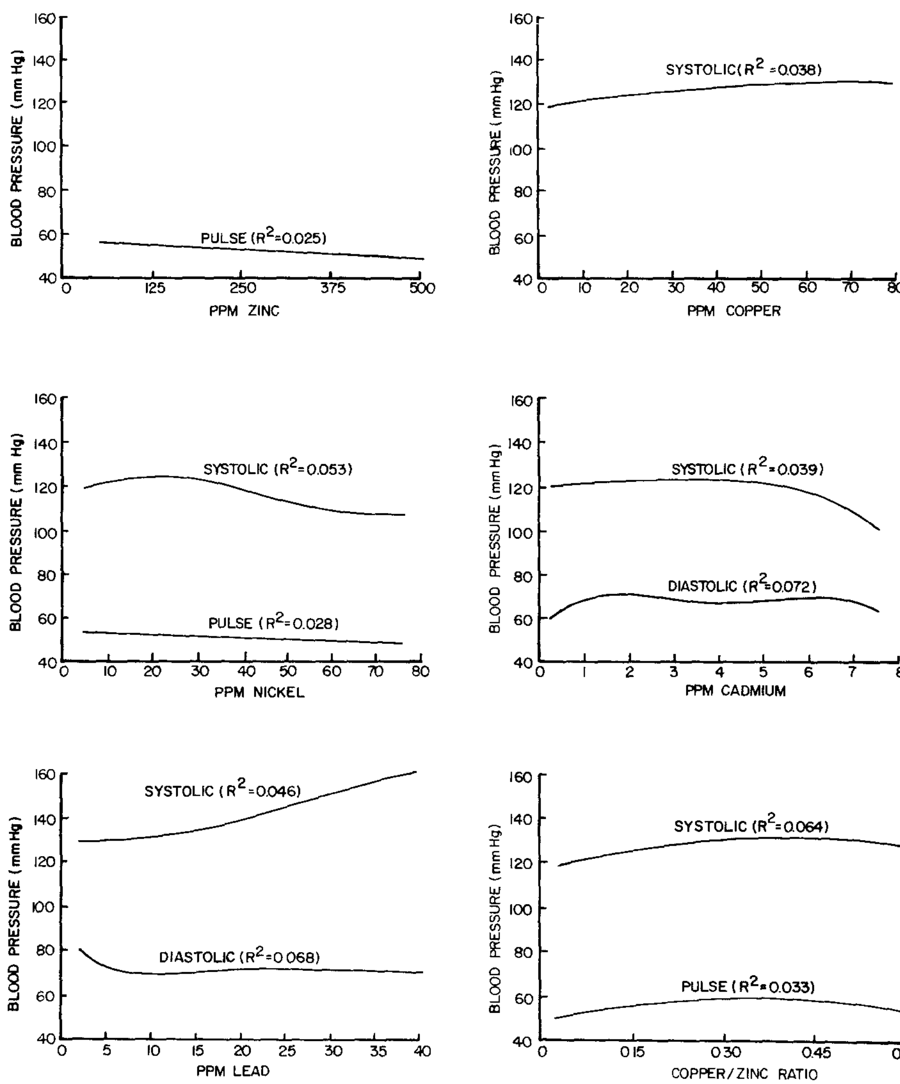

Fig. 1. Significant ($p \leq 0.05$) regression plots on hair element concentrations and blood pressures. Non-significant ($p \geq 0.05$) regressions are not shown.

Hair calcium, magnesium, iron, and chromium concentrations; and cadmium to zinc ratios were not related to any of the pressures.

DISCUSSION

Campers resided in South Carolina counties with a high incidence of hypertension and cardiovascular disease. Differences in blood pressure by race and sex were minimal in this age group. Mean blood pressures obtained are in agreement with other studies on adolescents (ADELMAN 1978; McLAIN 1976; MORRISON et al. 1980).

Concentrations of several minerals in the hair were related to blood pressures of individuals from which the hair was taken. Interpretation of results on hair minerals must be made with caution. An assumption often made is that hair mineral concentrations reflect body stores or environmental exposure (DALLY et al. 1978; KATZ 1979), but this may be more accurate for only some minerals. The washing procedure should remove minerals adsorbed to the hair. For each mineral studied, R^2 values were small. This suggests a weak association between hair mineral concentrations and blood pressures. Perhaps only a small fraction of a population had blood pressure affected by body mineral status, and this could explain the low R^2 values. Our study used controls matched for race and sex and concentrated on a narrow age group to correct for these factors which may influence mineral concentration.

Hair minerals have been associated with disease states. Lower hair chromium, magnesium, zinc, and manganese are found in diabetics (RUDOLPH 1978; HAMBIDGE et al. 1968). Ratios of elements were examined in our study since some are antagonist and may influence blood pressure (SCHROEDER 1965; HILL et al. 1963; WEBSTER 1979; BUNN and MATRONE 1966).

Animal studies on the relationship between diet, environment, hair minerals, and blood pressures would appear to be of value in the interpretation of future epidemiological studies on hair mineral concentrations and hypertension.

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