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Blood Pressure Levels Among Indigenous Children Living at Different Altitudes

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Abstract

The objective was to compare blood pressure (BP) levels in two groups of indigenous Argentine school children from similar ethnic backgrounds but living at different altitudes. 152 (46.3%) children (age 4–14 years) from San Antonio de los Cobres (SAC), at 3750 m above sea level, and 176 children (53.7%) from Chicoana (CH), at 1400 m, participated in this cross-sectional study. Data for children's anthropometry, BP, glucose, lipids, vitamin D, and insulin, as well as mothers' height and weight were assessed. Hypertension was defined as BP $\geq$ 95th percentile. The prevalence of overweight/obesity among children was significantly lower in SAC (n=17, 11.2%) than in CH (n=74, 42%) (BMI $>$ 85th percentile per US Centers for Disease Control and Prevention norms). However, the prevalence of hypertension was significantly higher among children in SAC (n=15, 9.9%) than among those in CH (n=2, 1.1%). Children were divided into 4 groups by mean arterial BP quartiles for comparison by analysis of variance. As mean arterial BP increased, age, BMI, glucose, triglycerides, triglycerides/ HDL-C, and insulin levels increased significantly. Multiple linear regression analyses showed that children's mean arterial BP was significantly associated with altitude adjusted for confounding variables ($R^2=0.42$). Furthermore, when mean arterial BP was replaced by systolic BP ($R^2=0.51$) or diastolic BP ($R^2=0.33$), similar results were obtained. Our results suggest that indigenous children who live permanently at high altitude have higher levels of BP, adjusted for confounding variables. Routine BP measurements conducted in the SAC community could be essential for the prevention of cardiovascular disease.

Key words: blood pressure, hypertension, high altitude, indigenous children.

Introduction

Hypertension, a modifiable cardiovascular risk factor, has been identified as the leading cause of cardiovascular disease (Lim et al. 2012). Studies have found links between high blood pressure (BP) and age, sex, race, geographic location, lifestyle behaviors, and cardiometabolic markers (Rosner et al. 2009). A previous randomized clinical trial reported progressive increases in both conventional and ambulatory BP with increasing altitude (Parati et al. 2014). However, research studying the association between high altitude and hypertension in children is lacking (Handler 2009; Aryal et al. 2016). Usual residence at an altitude of 2,500 m or above is the delimitation for high altitude (Moore et al. 1998; Niermeyer et al. 2001) because individuals might experience adverse symptoms such as hyperventilation, increased heart rate, vomiting, dizziness, and weakness above this elevation (Moore et al. 1998; Niermeyer et al. 2001). The size of the population currently living above 2,500 m is estimated to be over 100 million worldwide (Niermeyer et al. 2001). The effect of chronic hypoxic hypobaric conditions, induced by living at high altitude, on BP is uncertain and may vary in different populations. One study of the effects of high altitude found a significant association between chronic hypoxemia and cardiovascular risk in indigenous Andean populations (De Ferrari et al. 2014). We also found that indigenous Andean children living in Argentina at 3,750 m above sea level had higher cardiovascular disease markers than children from a mixed population in an urban setting, probably due to ambient hypoxia or ethnicity (Hirschler et al. 2012). However, there is very little information about BP levels in children from similar ethnic backgrounds but living at different altitudes. The objective of this study was to compare BP levels in two

groups of indigenous Argentine school children from similar ethnic backgrounds but living at different altitudes.

Methods

Study design

This cross-sectional study was designed to compare BP levels between two indigenous communities living at different altitudes. The study was approved by the Human Rights Committee of the University of Buenos Aires. Each caregiver and child gave written informed consent after an explanation of the study and before its initiation.

Study population

Indigenous communities of northwestern Argentina

This study included two indigenous communities of Diaguita descent in Salta province, northwestern Argentina, those of San Antonio de los Cobres (SAC) and Chicoana (CH) (Hirschler et al. 2012; Escuelas Argentinas. 2017). Details of the SAC community have been reported previously (Hirschler et al. 2012,). CH is a town located in the southwest Lerma Valley at 1,432 m above sea level, with a population of 4202 inhabitants (INDEC 2010). One out of the three schools existing in SAC was selected by simple randomization. Assuming that the prevalence of hypertension was close to 15% in SAC children (Hirschler et al. 2018.) and 5% in CH children; the estimated sample size of a total of 282 children would give a power of 0.80 at a significance level of 0.05. Assuming a possible loss of participation of at least 10%, the final number of 328 children included in the study is a large enough sample size to be consistent with the results. Another school of comparable socioeconomic status was selected among the elementary schools located in CH. In each school, children

were selected by simple randomization according to age group. The overall individual response rate was 94.2%.

Exclusion criteria were as follows: (1) missing anthropometric measurements, blood pressure, or biochemical data, (2) the use of medication that would affect blood pressure, lipids, and glucose levels, (3) children that did not fast and (4) the informed consent form not being signed. Participants included in our study sample had no significant difference in socioeconomic level, age, BMI, and waist circumference, with those that were excluded because of missing data. We chose to include only mothers and not both parents as only mothers could attend the evaluation with their children. Most fathers worked full time and could not attend.

Data collection

Demographic data, lifestyle behaviors, and children's anthropometry, BP, glucose, lipids, vitamin D, and insulin were assessed. Furthermore, mothers' height and weight were measured. Healthcare professionals performed all measurements. Sociodemographic characteristics recorded included level of education and the presence or absence of a refrigerator or a dirt floor in the house. These two indicators are used to identify families of very low socioeconomic status by the National Statistics and Censuses Institute of Argentina (Indec 2010). Validated questionnaires on lifestyle behaviors were completed by the same pediatrician, as previously described (Hirschler et al. 2009).

Height and weight were measured with participants wearing light clothing and no shoes. Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. BP was measured by certified medical professionals in a standardized

manner. BP was measured with the child in a seated position using a mercury sphygmomanometer, with the child's right forearm resting horizontally on a table. After the appropriately sized cuff for each child was applied (covering approximately two-thirds of the arm), the cuff was slowly inflated to 20 mm Hg higher than the level at which the radial pulse receded. The commencement of sound (Korotkoff phase I) indicated systolic BP, and the disappearance of sound (Korotkoff phase V) indicated diastolic BP (National High Blood Pressure Education Program, 2004). In the period of 1 to 2 minutes, two measurements were documented. The cuff was completely deflated between measurements. In the final analysis, the mean of the two measurements was calculated.

BP percentiles were determined using National Heart Lung and Blood Institute guidelines and adjusted for age, sex, and height percentile (National High Blood Pressure Education Program, 2004). Mean arterial pressure is considered a better indicator of perfusion to vital organs than systolic BP. Mean arterial BP is calculated using the following formula: diastolic BP multiplied by two plus systolic BP and then divided by three.

Definitions of overweight/obesity and hypertension in children

BMI z-scores (BMI-z) were also determined (Kuczmarski, et al. 2002). Children were classified as underweight (<5th percentile), normal weight (5th to <85th percentile), overweight (85th to <95th percentile), or obese ($\geq$ 95th percentile) according to US Centers for Disease Control and Prevention (CDC) norms (Kuczmarski, et al. 2002). Pre-hypertension and hypertension were defined as systolic and/or diastolic BP $\geq$ 90th to <95th percentile or $\geq$ 95th percentile, respectively, according to age, sex, and height (National High Blood Pressure Education Program, 2004).

Blood samples were obtained from subjects after a 10-hour overnight fast. All samples

were analyzed in a single laboratory. We had stored SAC and CH serum samples at -70°C and both groups were assessed together. Plasma glucose was obtained by the glucose oxidase technique and serum lipids were measured using the Architect c 16000 instrument (Toshiba, Kanagawa, Japan). Abnormal lipid levels were defined according to the National Institute of Health's Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents. Serum insulin levels were determined by radioimmunoassay (Diagnostic Products Corporation, Los Angeles, Ca). Serum vitamin D levels were measured using a radioimmunoassay kit (DiaSorin, Stillwater, Minn., USA).

Maternal anthropometric measures

Weight, height, and BMI were measured in all mothers. Overweight was defined as BMI ≥ 25 and < 30 kg/m² and obesity as BMI ≥ 30 kg/m², according to the National Cholesterol Education Program's Adult Treatment Panel III (National Cholesterol Education Program (NCEP) 2002).

Statistical analysis

Descriptive statistics for raw variables are presented as mean $\pm$ SD values. Asymptotic Gaussian test was used to compare proportions due to the sample size. When comparing two groups with normally distributed data, a Student's *t*-test was performed. Variables with a skewed distribution were logarithmically transformed for analysis. Bonferroni's adjustment was carried out when many comparisons were performed.

For ANOVA test, homogeneity of variances was tested. When it was not validated, Brown Forsythe test was performed.

The primary focus of the study was to compare BP levels between two indigenous communities living at different altitudes. Multiple linear regression analyses were performed to determine the association between BP levels and altitude adjusted for confounding variables. P values of < 0.05 were considered statistically significant. Analyses were performed using IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA) statistical software package.

Results

Anthropometric measurements were performed in 348 children. However, 20 children were excluded from the study based on the previously stated exclusion criteria: 19 were missing BP data and one participant did not sign an informed consent form. Therefore, 328 (158 females) indigenous Argentine school children from SAC and CH, aged 4–14 years, were included in the study. We compared the data of 152 children (72 females) from SAC with those of 176 children (86 females) from CH. A total 43% of parents in SAC and 53% in CH had an elementary education or less ($P<0.01$); 22 (14.5%) families in SAC and 5 (2.8%) in CH did not have a refrigerator at home ($P<0.01$). Even though all participating families from both communities had low socioeconomic status, socioeconomic levels were significantly lower in SAC than in CH.

Lifestyle Behaviors

Approximately 53% ($n=80$) of SAC children versus 67% ($n=111$) of CH children drank two or more glasses of milk per day ($P<0.01$); 2% ($n=3$) of children in SAC versus 7% ($n=12$) of those in CH skipped breakfast ($P=0.03$); 46.7% ($n=30$) of SAC children versus 51.2% ($n=88$) of CH children watched TV more than two hours per day ($P>0.05$); 84.5%

(n=125) of SAC children versus 85.4% (n=146) of CH children drank two or more glasses of sweet beverages per day ($P>0.05$). In both communities and in 90% of cases, the sugary beverages consumed by children were juices made from concentrated powder diluted in water.

Anthropometric measurements and BP levels of children from SAC and CH

Table 1 describes clinical characteristics of the sample. There was no significant difference in age between SAC and CH children. However, mean weight, height, waist circumference, and BMI, adjusted for age and sex, were significantly lower in children from SAC than in those from CH. In contrast, systolic and diastolic BP were significantly higher in SAC than in CH children (Table 1; Figure 1). Furthermore, mean arterial BP was higher in SAC compared with CH children; indicating that there were more children in SAC with higher mean arterial BP values than those in CH (Table 1; Figure 1).

The prevalence of overweight/obesity was significantly lower among children in SAC (n=17, 11.2%) than among those in CH (n=74, 42%) (BMI $\geq$ 85th percentile per CDC norms). There was not a significant difference in age and sex between normal weight and overweight/obesity in SAC and CH children. The prevalence of hypertension among children was significantly higher in SAC (n=15, 9.9%) than in CH (n=2, 1.1%). There were no significant differences in age between normal BP and hypertension in SAC and CH children. Therefore, the prevalence of hypertension was approximately ten-fold higher in SAC than in CH children, whereas the prevalence of overweight and obesity was approximately four-fold lower in SAC than in CH children. There were no significant differences in age and BMI between mothers in SAC and CH.

Metabolic characteristics of children from SAC and CH

Table 1 describes metabolic characteristics of the sample. Glucose levels were significantly higher in SAC than in CH children. Regarding the lipoprotein profile, HDL-C levels were significantly lower in SAC than in CH children, whereas total cholesterol and triglycerides were significantly higher in SAC than in CH. Furthermore, triglycerides/HDL-C ratios were significantly higher in SAC than in CH children. However, insulin levels were not significantly different between SAC and CH. Vitamin D levels were significantly higher in SAC than in CH. None of the children had abnormal glucose levels. There was a higher prevalence of hypertriglyceridemia in SAC 42.1% (64) than in CH 27.3% (48) children as well as lower HDL-C in SAC 26.9% (41) than in CH 20.4% (36). There was not a significant difference in the prevalence of these markers between sexes in both communities.

*Variables related with BP levels:**BP quartiles*

Three hundred and twenty-eight subjects were divided into 4 groups by mean arterial BP quartiles for comparison by analysis of variance, with age and BMI and other variables entered as covariates. The mean arterial BP value was used because it constitutes a synthetic variable that integrates the values of both systolic and diastolic BP. The behavior of the covariates was consistent when they were divided by quartiles according to systolic and diastolic BP. As mean arterial BP increased, age, BMI, glucose, triglycerides, triglycerides/ HDL-C, insulin, and vitamin D levels increased significantly (Table 3). Even though HDL-C levels decreased, the differences did not reach significant levels. When mean

arterial BP was replaced by systolic BP or diastolic BP, results did not change, except for mean triglycerides/HDL-C, which did not reach significant levels between quartiles.

Multiple linear regression analysis

Multiple linear regression analysis showed that children's mean arterial BP was significantly associated with location, and children's BMI, adjusted for age, sex, triglycerides, glucose, insulin, vitamin D, and maternal BMI ($R^2=0.42$) (Table 4). Furthermore, when mean arterial BP was replaced by systolic BP ($R^2=0.51$) or diastolic BP ($R^2=0.33$), similar results were obtained.

Discussion

We have demonstrated that children from SAC had higher BP levels than CH children adjusted for confounding variables. The prevalence of hypertension was ten-fold higher in SAC than in CH. Furthermore, mean arterial BP was associated with several cardiometabolic markers in indigenous children suggesting a higher cardiometabolic risk in children living at approximately 4000 meters. This is the first known study in Argentina to examine the effect of altitude on BP levels in two similar indigenous communities living at different altitudes. BP levels were significantly higher in children living at 3750 m compared with a community of a similar background but living at a lower altitude.

In this study, we were able to consider several potential risk factors for childhood hypertension, including family socioeconomic status and maternal BMI, which have been shown to be associated with hypertension (van den Elzen et al. 2004). Even though both communities had low socioeconomic status, that of families in SAC was significantly lower than the socioeconomic status of CH families. However, we did not find a significant

association between a family's socioeconomic or maternal BMI status and children's BP in the regression analysis.

Consistent with a previous study, we showed significant relationships between BP and BMI in indigenous children in the regression analysis (Lurbe et al. 2001). However, although the prevalence of overweight/obesity was significantly lower in children from SAC (11%) than in those from CH (42%), the prevalence of hypertension was ten-fold higher in SAC than in CH children. This contradictory result could be due to a variety of factors including lifestyle behaviors, socioeconomic status, chronic hypoxia, aridity, cold and windy weather, or other environmental conditions associated with high altitude (Moore et al. 1998). Although both populations have a similar ethnic background (Diaguita), the weather, landscape, and socioeconomic status of the community are significantly different in these two regions. (INDEC 2010). CH is located in the southwest Lerma Valley at 1,432 m above sea level with a mean annual temperature of 17°C (INDEC 2010). In contrast, SAC is in the mountains at 3,750 m, with a mean annual temperature of 7.7°C. and mean annual wind speed of 21 km/h (INDEC 2010). Therefore, CH has a less severe and warmer climate than SAC. Furthermore, the economic level of the SAC community was significantly lower, which might contribute to the lower prevalence of obesity in SAC children (Encuesta nacional de Nutricion y Salu. 2011.). Moreover, the differences in dietary and physical activity habits may play a role in the lower rate of obesity in SAC children (Encuesta nacional de Nutricion y Salud. 2011.) The sympathetic system is also a key regulator of leptin production in white adipose tissue. High altitude is also associated with high leptin levels, which might increase sympathetic nerve activity that is related to adipose tissue (Mark et al. 2013). This could be another mechanism

involved in the decrease of weight (Mark et al. 2013). In addition, hypoxia stimulates hypoxia inducible factor 1, the main regulator in the expression of the leptin gene—a hormone secreted by adipose tissue that has a negative feedback on appetite—and inversely associated with obesity (Sierra-Johnson et al. 2008). A cross-sectional study conducted at different altitudes in the Everest region of Nepal also found that obesity decreased with increasing altitude (Sherpa et al. 2010). Our findings present a striking example of the variation in obesity prevalence found among populations of similar indigenous backgrounds under different environmental circumstances.

Hypertension is one of the most common risk factors for cardiovascular disease. A previous study highlighted the importance of BP in children, which has been suggested to be a good predictor of adult hypertension and cardiovascular disease (Domanski et al. 2002). Thus, routine BP measurement during childhood for the prevention of high BP in this community could be important for optimal risk reduction of cardiovascular disease. The prevalence of hypertension in SAC (10%) was higher than that in CH (1%) children. A previous study performed among Turkish children aged 10 years showed that children living at high altitude (1,725 m) had higher systolic and diastolic BP levels compared with children from similar ethnic backgrounds who lived at sea level (Arslan et al. 2003). Similar findings have been reported in children from Pakistan, with a prevalence of hypertension of 12.2% (Jafar et al. 2005).

In contrast, a recent review suggests that the risk of hypertension and cardiovascular disease decrease with an increase in altitude. However, the authors acknowledge that most of these studies could have been affected by the study design and variables such as different ethnicities, migration, and associated comorbidities (Savla et al.

2018). Our study design, however, controlled for variables by only including non-migrant school children without comorbidities and who all belonged to the same ethnic group.

It is difficult to quantify all the risk factors that contribute to childhood hypertension. However, the consistently cold and windy climate, lifestyle behaviors, low socioeconomic status, and higher rates of dyslipidemia of the SAC community likely play important roles in the development of hypertension (INDEC 2010). Salt intake also has been associated with high blood pressure levels, however we were unable to measure salt intake in both communities in this study (He et al. 2014). Adaptation to hypoxia is not the same in Tibetan and Andean individuals living at the same altitude: while Tibetans have a higher hypoxic ventilatory response, Andeans have higher hemoglobin concentrations (Beall 2001). It is worth noting that higher hematocrit levels at high altitudes were related to the increased risk of cardiovascular disease (Beall 2001). In addition, cold climates could induce arteriolar vasoconstriction because of the thermo-regulatory response (Brook 2017;Sun 2010.). They can also trigger the hypothalamic pituitary adrenal axis and sympathetic nervous system activation (Brook 2017). Chronic exposure to high altitude results in increased sympathetic and decreased parasympathetic activity, which leads to elevated BP (Parati et al. 2014; Zheng et al. 2012). Furthermore, the decrease of partial pressure gradients hinders the exchange of gas, causing chronic insufficiency of oxygenated blood circulation (Zheng et al. 2012). This results in the decrease in the blood being supplied to the kidneys and the consequent release of renin (Howden et al 2012). This process increases the vasoconstriction of arteries (Howden et al 2012). Therefore, cold climate, chronic hypoxia, and elevated hemoglobin levels due to high altitude could have an influence on BP among indigenous children living in SAC.

This study also showed that glucose, triglycerides, vitamin D, and insulin levels increased significantly with increasing mean arterial BP; suggesting that high BP was associated with a worse cardiometabolic profile in indigenous children living at high altitude.

It is interesting to note that the prevalence of dyslipidemia, another cardiometabolic marker, was also significantly higher in SAC than in CH children. Consistent with our results, a study performed in the San Pedro de Cajas district, located in the Central Andes of Peru at an altitude of 4,100 m, showed a high prevalence of hypertriglyceridemia (53.9%) and of low HDL (45.3%) in Indigenous descendants of the Amerindian populations (Mohanna et al. 2006). Consistently, a previous study found a significant association between chronic hypoxemia and cardiometabolic risk in Andean indigenous populations (De Ferrari et al. 2014). Furthermore, higher levels of triglycerides/HDL-C index were associated with increased proportions of small and dense LDL particles (Fiori et al. 2000). It is interesting to note that as mean arterial BP quartiles increased, triglycerides/HDL-C increased significantly, suggesting that higher BP is associated with future cardiovascular disease. Our results suggest that indigenous children who live permanently at high altitude have higher levels of BP, adjusted for confounding variables. As far as we know, this is the first study showing higher BP levels among indigenous children living at approximately 3,750 m above sea level, as compared with indigenous children living at 1,400 m above sea level.

Study limitations

First, we could not determine a causal relationship between hypertension and altitude because of the cross-sectional study design. Second, the two BP measurements were obtained at one visit during physical examinations conducted in both communities.

Ideally, hypertension should be defined using three repeated BP measures obtained on three separate occasions (National High Blood Pressure Education Program. 2004). Blood pressure was measured in two occasions in the same day. Unfortunately, due to economic limitations, ambulatory BP monitoring over 24h was not performed, even though the effects of hypoxia are more evident on 24h ambulatory BP monitoring than on conventional BP readings (Parati et al. 2014). Third, salt intake was not measured in both communities. Fourth, the results of this study, conducted in a sample of indigenous SAC and CH children, may not be applied to children of other communities without further confirmation. Fifth, no control group at sea level was included, so that we could compare two different altitudes, but we could not know whether subjects living at the lower altitude could be considered similar or not to those living at sea level. This is even more an issue in children, in whom conventional BP measurements are known to be affected by limitations, mainly when performed in a single visit.

Despite these limitations, this study contributes to the literature by examining apparently healthy school children from two indigenous communities from the Andes mountain region. Furthermore, there was a high response rate of the children, and the data collected were through measurements taken by our team and were not self-reported. Finally, we used regression models and simultaneous adjustment of confounding variables.

Conclusions

Children living in SAC had a worse cardiometabolic profile, with higher BP levels, than those living in CH. This study shows a higher prevalence of hypertension in SAC children compared with a community of a similar background but living at a lower altitude.

Routine BP measurements conducted during childhood in the SAC community could be essential for the prevention of high BP and future cardiovascular disease.

Author Contributions

CG, GM, and CM, analyzed the data and drafted the manuscript, edited the manuscript for intellectual content, and provided critical comments on the manuscript.

Disclosures: There are no potential conflicts of interest.

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Figure 1: Blood pressure (BP) levels in children from San Antonio de los Cobres (SAC) and Chicoana (CH), Argentina. Boxplot; median systolic (SBP), diastolic (DBP), and mean BP (MBP) levels and interquartile ranges in SAC and CH children are presented separately. The boxes define the 25th and 75th percentiles and enclose the median; the extensions define the range of values. Boxes in dark grey represent systolic BP, light grey diastolic BP, and white mean arterial BP.

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Table 1: Clinical and Metabolic Characteristics

	SAC		CH	
Age in years at screening	9.02	±2.14	9.37	±2.11
Birth Weight	3.07	±0.51	3.22	±0.63
Weight **	29.26	±8.81	37.52	±13.74
Waist Circumference**	60.06	±8.29	67.52	±13.05
Height (cm)**	130.4	±12.41	137.64	±13.41
z-Height**	-0.80	±0.85	0.75	±1.10
BMI (kg/m**2)**	16.83	±2.69	19.27	±4.41
Z-BMI**	-0.14	±0.99	0.68	±1.21
Maternal age in years	33.22	±7.14	34.4	±7.94
Maternal BMI	26.19	±4.30	28.88	±5.4
Systolic: BP mm Hg**	87.09	±13.84	69.65	±14.35
Diastolic: BP mm Hg**	57.75	±13.77	47.58	±10.96
Mean arterial BP mm Hg**	67.53	±13.25	54.93	±13.91
Cholesterol mg/dL**	157	±25	148	±35
HDL-C mg/dL*	46	±8	48	±11
LDL-C mg/dL**	90	±22	83	±22
Triglycerides mg/dL**	104	±39	88	±41
Triglycerides/HDL-C**	2.4	±1.1	1.9	±1.2
Cholesterol/ HDL-C**	3.5	±0.7	3.1	±0.8
Glucose mg/dL**	90	±7	80	±6
Insulin IU/dL	5.3	±2.7	6.6	±4.8
Vitamin D ng/dL**	17.5	±5.2	22.0	±5.1

BMI, body mass index; BP, blood pressure. Data are presented as mean ± SD. Z-score is a quantitative measure of the deviation of a specific variable taken from the mean of that population. CDC z-BMI takes into account age and gender. Significance:

*p<0.05, **p<0.01.

Table 2. Clinical Characteristics according to Mean Arterial BP Quartiles*

	Quartile1 (26.6-46.6) (n=81)	Quartile 2 (50.0-56.6) (n=74)	Quartile 3 (60.0-70.0) (n=100)	Quartile 4 (73.3-106.6) (n=73)
Age (years)** (a)	8.1 ±1.8	9.3 ±2.2	9.8 ±2.1	9.6 ±2.2
BMI* (b)	17.0 ±3.1	18.2 ±3.8	18.7 ±4.0	18.6 ±4.6
ZBMICDC	0.2 ±1.2	0.3 ±1.1	0.4 ±1.3	0.3 ±1.1
Vitamin D ng/dL (a)	22.7 ±5.3	19.8 ±4.9	18.5 ±5.2	26.6 ±4.3
Glucose mg/dL** (a)	74.8 ±7.0	81.6 ±9.3	82.0 ±7.6	18.8 ±6.1
Cholesterol mg/dL	146.8 ±36.6	146.8 ±29.8	156.9 ±30.5	158.2 ±26.8
HDL-C mg/dL	48.3 ±11.3	46.2 ±9.5	47.4 ±9.7	46.5 ±8.0
Triglycerides mg/dL** (c)	81.8 ±32.6	84.2 ±32.3	108.3 ±46.1	105.3 ±43.4
Insulin ng/dL*(b)	5.1 ±3.1	6.2 ±3.9	7.0 ±5.1	6.6 ±3.4
Triglycerides/HDL-C**(d)	1.9 ±1.3	1.9 ±0.8	2.5 ±1.3	2.4 ±1.2

SI conversion factors: To convert HDL-C to millimoles per liter, multiply by 0.0259; triglycerides to millimoles per liter, by 0.0113.

*Data are expressed as mean ±SD) (determined by analysis of variance) unless otherwise indicated. Values for age, BMI, glucose level, cholesterol, triglyceride level, insulin level, and Triglycerides/ HDL-C increased significantly with increasing MABP. Even though HDL-C decreased the difference was not significant. Significance: *p<0.05 and **p<0.01, # p<0.01

(a)Comparing quartiles 1 with quartile 2, 3 and 4.

(b)Comparing quartile 1 with quartile 3.

(c) Comparing quartiles 1 and 2 with quartile 3 and 4.

(d) Comparing quartiles 1 and 2, with quartile 3 and 4 with quartile 1 and 2

Table 3: Multiple Linear Regression Analysis

	Non Standardized coefficients		t	Signif.	R ²
	B	Standard Error			
Age	0.07	0.04	1.94	0.05	0.42
Sex	2.78	1.74	1.6	0.11	
BMI	1.19	0.31	3.85	<0.01	
Location	-17.44	2.38	-7.32	<0.01	
Triglycerides	0.03	0.02	1.34	0.18	
Insulin	-0.52	0.32	-1.63	0.1	
Glucose	0.02	0.15	0.13	0.9	
Vitamin D	0.14	0.15	0.92	0.36	
Maternal BMI	0.07	0.17	0.43	0.66	

Dependent variable mean arterial BP