

Salt intake and blood pressure in the university of Asuncion-Paraguay youths: a preliminary study

O consumo de sal e sua relação com a pressão arterial em jovens da Universidade de Assunção-Paraguai: estudo preliminar

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ABSTRACT

Introduction: High salt intake is a major risk factor related to many cardiovascular and renal diseases. World Action on Salt and Health is a newly formed coalition of health professionals whose goal is to implement changes in salt consumption in their respective countries for the goal of reducing blood pressure. In the same vein, we have decided to study the amount of salt intake in Paraguay to determine if a relationship exists between salt intake and blood pressure. **Objective:** A preliminary study was undertaken to determine salt intake in Paraguay and its relationship with blood pressure, in order to implement a national program to combat hypertension. **Methods:** Cross-sectional, observational study of 72 students from various universities in Asuncion (age range 22-30 years). Sodium excretion in 24-hour urine samples and blood pressure were measured. Assuming a steady state, urinary sodium excretion was converted into grams of salt ingested per day. **Results:** Only 7% of the 72 participants had a salt intake less than the recommended maximum of 5 g/day. Forty-six percent had a blood pressure between 120-139 mmHg and 3% had stage 1 hypertension. There was no significant relationship between sodium excretion and blood pressure. **Conclusion:** Salt intake and blood pressure were found to be significantly elevated in young adults in Paraguay and argues for the importance of instituting a national campaign to reduce salt intake in this society.

Keywords: blood pressure, sodium chloride dietary, young adult.

RESUMO

Introdução: O elevado consumo de sal é um importante fator de risco relacionado a muitas doenças cardiovasculares e renais. A Ação Mundial sobre Sal e Saúde (WASH) é uma coalizão recém-formada de profissionais de saúde, cujo objetivo é modificar o consumo de sal em seus respectivos países com a finalidade de reduzir os valores de pressão arterial. Neste contexto, decidimos estudar a quantidade de ingestão de sal no Paraguai para determinar se existe uma relação entre a ingestão de sal e valores de pressão arterial. **Objetivo:** Um estudo preliminar foi realizado para determinar o consumo de sal no Paraguai e sua relação com a pressão arterial, a fim de implementar um programa nacional para combater a hipertensão. **Métodos:** Estudo transversal, observacional de 72 estudantes de várias universidades de Assunção (faixa etária 22-30 anos). Excreção de sódio em amostras de urina de 24 horas e valores de pressão arterial foram medidos. Assumindo um estado de equilíbrio, a excreção urinária de sódio foi convertida em gramas de sal ingeridos por dia. **Resultados:** Apenas 7% dos 72 participantes tinham uma ingestão de sal menor ao máximo recomendado de 5g/dia. Quarenta e seis por cento tinham uma pressão arterial entre 120-139 mmHg e 3% tinham hipertensão estágio 1. Não houve relação significativa entre a excreção de sódio e pressão arterial. **Conclusão:** O consumo de sal e valores de pressão arterial encontrados foram significativamente elevados em adultos jovens do Paraguai, e defende-se a importância de se instituir uma campanha nacional para reduzir a ingestão de sal na sociedade.

Palavras-chave: adulto jovem, coreto de sódio na dieta, pressão arterial.

Data de submissão: 22/05/2012.
Data de aprovação: 23/10/2012.

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INTRODUCTION

High salt intake is a major risk factor related to many cardiovascular and renal diseases. World Action on Salt and Health (WASH)¹ is a newly formed coalition of health professionals from different countries whose goal is to implement changes in salt consumption in their respective countries for the goal of reducing blood pressure. In the same vein, we have decided to study the amount of salt intake in Paraguay to determine if a relationship exists between salt intake and blood pressure. For this pilot study, university students were the population sampled.

The awareness of a link between salt and hypertension has existed for decades. While many studies have proven this relationship, other studies have demonstrated that this relationship is not universal. For example, a study published in 1994 in the *American Journal of Hypertension* demonstrated that lowering salt intake reduces blood pressure in normal weight people, but in overweight populations at 110% to 160% of their ideal weight, the reduction in salt intake is not as beneficial as weight loss.² The Dietary Intervention Study of Hypertension (DISH) trial also demonstrated that a diet low in sodium and high in potassium reduced blood pressure, and this was especially true in non-obese patients.³ The Trial of Antihypertensive Interventions and Management (TAIM) provide no support for the sole use of a low sodium/high potassium diet as a practical therapeutic strategy in maintaining blood pressure control in the moderately obese. They also found that a low-salt diet was associated with a high rate of recidivism, suggesting that sodium restriction may not be a long-term therapeutic option for blood pressure control in mild hypertension.² In another study published by the *Lancet* in 1983, Silman *et al.* found no significant difference between the intervention group given a low salt diet and the control group, suggesting “that the antihypertensive effect of a restricted sodium diet may be related to the increased consultation and monitoring activity of such intervention rather than to the dietary manipulation itself”.⁴ On the other hand, the International Study on Salt and Blood Pressure, INTERSALT, the largest study of blood pressure and salt intake, showed that sodium was significantly related to blood pressure.⁵ Bibbins-Domingo *et al.* concluded that modest reductions in dietary salt could substantially reduce cardiovascular events and medical costs, and should be a public health target.⁶ As all

of the aforementioned studies were only conducted in adult populations, we sought to examine if a similar relationship existed between salt and blood pressure in young adults between the ages of 20 and 30 years old. Should a relationship be found between salt intake and blood pressure in Paraguay, this has implications for earlier therapeutic interventions to help prevent cardiovascular and renal disease.

METHODS

The study population consisted of 72 University of Asuncion undergraduate and graduate students aged 22-30. The following were collected from each subject:

- Questionnaire dealing with major confounding factors (such as usual diet, smoking, alcohol ingestion, hereditary factors, medication taking, personality test, exercise).
- Blood pressure measurements.
- Height and weight, from which body mass index (BMI) was calculated.
- 24-hour urine sample, which were then analyzed in the Hospital of the National University of Asuncion laboratory.

Sampling and recruitment:

The majority of the participants were university graduates or undergraduates known to the investigators. The inclusion criteria were: University students between the age of 20 and 30 years old. Exclusion criteria were: pregnancy, current or past diagnosis of hypertension, and individuals on special diets or with dietary restrictions.

- The study was conducted in winter to prevent loss of sodium through sweat, and the subjects were instructed to maintain their usual eating habits on the day of the study. Subjects were educated about proper urine collection and storage (i.e. they were instructed to keep urine samples in a cool place, if possible the refrigerator of their home, otherwise they were provided with cooling boxes to store the sample in between collections.)
- Study questionnaire: each participant received a questionnaire based on the WHO format,⁷ containing questions about gender, age, alcohol intake, smoking, diet, physical activity, heredity factors and addition of extra salt to the food.
- Blood pressure measurement: As standardized measurements of blood pressure were crucial, a sphygmomanometer was used with the bell

of a Littman stethoscope for all blood pressure recordings. Uniform methods of measurement were applied, including preparation of the participant (no fasting but avoid eating, smoking or strenuous activity in the 30 minutes before measurement, seated at rest with uncrossed legs for 5 minutes, empty bladder). Blood pressure was recorded three times in the same day with a separation of five minutes between each take and an average was calculated and recorded. The blood pressure was taken again in a different day again three times and the average of the two separates day was calculated and was used as the subject's blood pressure.

- Urinary sodium measurement: The basic method that was adopted in this study was a single timed 24-hour collection. This was preferred to an overnight sample, as diurnal variations in electrolyte excretion exist between people. Fecal losses of sodium are generally low, and sodium loss through sweat was also thought to be minimal in acclimatized people during the winter months, which is when the study occurred.

- Timing and urine collection: Each participant was provided with a 2 L bottle which was labeled with the subject's name. The 24-hour collection began after each participant had completely emptied his or her bladder in the morning of the study, the next urine and all the subsequent urines had to be collected in the bottle until the first urine of the next morning. The urine samples were kept in the refrigerator of each participant in between urine collections, and samples were retrieved the following day and kept in a cold box during transport to the lab. Participants were verbally instructed to stay at home during the entire duration of the 24-hour urine collection, and urine creatinine was measured to confirm completeness of the 24-hour collection. A 24-hour urine collection is expected to contain greater than 15 mg of creatinine per kilogram of weight for women and greater than 20-25 mg of creatinine per kilogram of weight for men. If a less than that was contained in the sample, the sample was assumed to be incomplete and 24-hour collection had to be repeated.

- Sodium and potassium was analyzed by emission flame photometry. Creatinine was measured by Jaffe method.

- Urine sodium in milliequivalents was converted to grams using the following equation:

$$U_{\text{Na}}/17 = \text{Grams of Na}$$

- Stepwise multiple regressions were used to investigate the relationship between sodium excretion and independent variables.

RESULTS

Baseline characteristics of the studied population are shown in Table 1. Of the 72 volunteers, 35 (48.6%) were female and 37 (51.3%) were male. The age range was from 22 to 30 years and the mean was 25.3 years old. The percentage of students with a family history of hypertension was 76.5% and only 15.6% of the population studied was found to regularly engage in physical activity.

TABLE 1 CHARACTERISTICS OF THE STUDY POPULATION

	Number	72
Age, years		25.3
Gender, % male		51.3
Blood pressure, mm Hg Systolic		117.2
Diastolic		78.4
Mean		91.2
24-hour urine Sodium, mEq/24hs		161.6
Creatinine, gr/24hs		2.0
Body Mass Index, kg/m ²		24.1
Family history of hypertension, %		76.5
Regular physical activity, %		15.6

The mean MBP (mean blood pressure) was 91.18 mmHg. The mean 24 hour urine sodium excretion was 161.57 mEq/day. The mean 24 hour urine creatinine excretion was 2 g/day. The mean BMI was 24.1 kg/m².

The amount of sodium consumed by our sample can be seen in Table 2. Less than 7% of population study consumed the recommended amount of sodium (less than 5 grams per day.) Ninety-three percent of the population studied consumed more than the recommended maximum of 5 g of salt per day, and 10% consumed extreme quantities of salt (greater than 14 g of salt per day.) The mean salt intake was 9.4 grams per day.

Figure 1 shows the frequency of use of extra salt during meals based upon daily estimated salt intake. Forty percent of the people consuming less than 5 grams per day never added extra salt to their meals, whereas 60% of people consuming less than 5 grams per day do so occasionally. All of the people who consume between five and 10 g of salt per day, 14% always add extra salt to their food, and 51% never add extra salt.

TABLE 2 DISTRIBUTION OF ESTIMATED DIETARY SALT INTAKE FROM 24 HOUR URINE SODIUM EXCRETION AND ACCORDING THE DIFFERENT RANGES OF SYSTOLIC BLOOD PRESSURE

Salt in grams	N	%
< 5.0	5	7
5.0-5.9	4	6
6.0-6.9	12	17
7.0-7.9	7	10
8.0-8.9	14	19
9.0-9.9	6	8
10.0-10.9	7	10
11.0-11.9	6	8
12.0-12.9	2	3
13.0-13.9	2	3
= 14.0	7	10

BP (mmHg)	Salt in grams/day	N (%)
< 120	< 5g	3 (9)
	5-10g	24 (71)
	10-14g	6 (18)
	> 14g	1 (3)
120-139	5 g	2(6)
	5-10g	16 (49)
	10-14g	11 (33)
	>14g	4 (12)
140-159	< 5g	0 (0)
	5-10g	1 (50)
	10-14g	1 (50)
	>14g	0 (0)

In people who consume between 11 and 14 g of salt per day, 18% always add extra salt, and 47% never do. And finally, in the group who consumed greater than 14 g of salt per day, 29% always added extra salt and 14% never did. A one-way ANOVA, using “extra salt added” as the independent variable and natriuresis the dependent variable, we found that the more frequently extra salt was added, the higher the degree of natriuresis ($r = 0.08$, $p = 0.06$) (Figure 1).

49.3% of the participants had a systolic blood pressure (SBP) less than 120 mmHg and 50.7% had a SBP higher than 120 mmHg, of which 31 were males and only 4 were female. The mean SBP in males was 125 ± 9.2 mmHg and in females 109.6 ± 9.5 mmHg ($p < 0.0001$). Males were found to have a higher BMI (26.4 ± 3.2) than females (21.9 ± 2.6), $p < 0.0001$. Natriuresis was found to be higher in males (176.3 ± 73.5) than in females (143.2 ± 60.8), $p = 0.02$ (Figure 2).

Of the participants with a SBP < 120 mmHg, almost 10% had an intake of less than 5 grams/day and only 3% had a salt intake greater than 14 grams per day. When examining data from individuals whose SBP was between 120 and 139 mmHg, only 6% were found to consume less than 5 grams of salt per day; 94% consumed greater than that. None of the participants with SBP ≥ 140 consumed less than 5 grams of sodium per day.

Within the group having a SBP less than 120 mmHg, 77% of subjects had natriuresis between 100 and 200 mEq/24hs and only 12% natriuresis higher than 200 mEq/24hs. Table 3. No significant relationships were found between SBP and natriuria ($p = 0.6$ $r = 0.003$) or between DBP and natriuresis ($p = 0.7$ $r = 0.002$.) (Figure 3).

Comparing mean blood pressure (MBP) values, 59% were found to have a MBP less than 93 mmHg and 41% had a MBP higher than 93 mmHg. The lower MBP group consisted primarily of females (33 females and eight males), whereas the higher MBP group was predominantly male (26 males and two females). In both groups the majority of subjects had natriuresis between 100 and 200 mEq/24hs, 71% in the former group and 82% in the latter.

DISCUSSION

Thirty-four subjects (49.3%) had a systolic blood pressure less than 120 mmHg and 35 individuals (51.7%) had a systolic blood pressure higher than 120 mmHg, all of which were male and only four females. We can correlate this finding with a study from La Plata, Argentina, where blood pressure was measured among medical students and there was a clear predominance of males over females with high blood pressure.⁸

Forty-six percent of the patients in the study had a SBP between 120-139 mmHg and most of these patients had an intake higher than 5g/day, with around 80% eating between 5 and 14 grams of salt per day. This is consistent with publications that establish a close relation between salt intake and hypertension, and there is evidence that the current high sodium diet is an important factor in the genesis of essential hypertension.⁹

We found that 3% of the young adults already had stage 1 hypertension, 50% of whom had a sodium intake between 5 and 10 grams/day and 50% with an intake greater than 10 grams/day. This data

Figure 1. Prevalence of frequency of use of extra salt during meals based upon daily estimated salt intake. Oneway Anova showing relationship between natriuria (mEq/24hs) and extra salt addition, where 0: never; 1: sometimes; 2: always. ($r = 0.08$; $p = 0.06$).

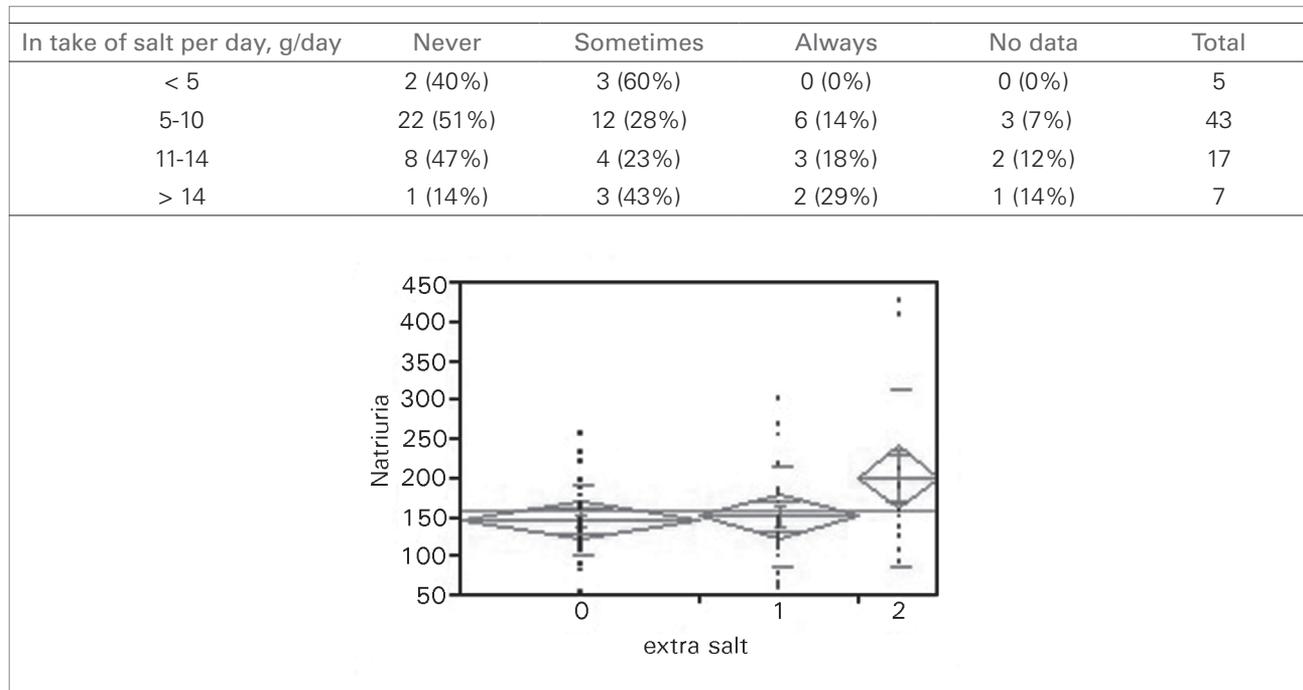


Figure 2. BMI ($p < 0001$), Natriuria ($p = 0.02$) and SBP ($p < 0001$) related to sex, where 0: female and 1: male.

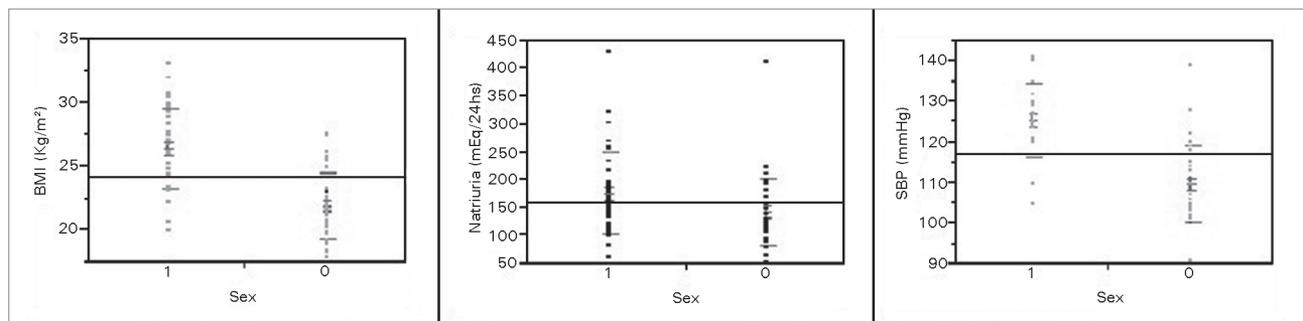
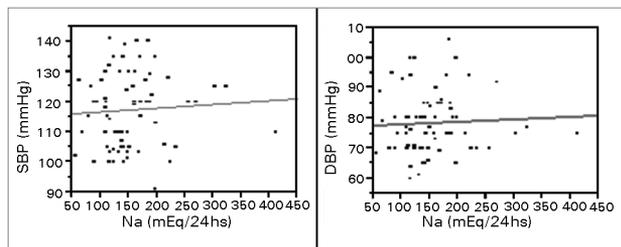


TABLE 3 24-HOUR URINE SODIUM EXCRETION STRATIFIED BY BLOOD PRESSURE AND GENDER

		Natriuria			
		100 mEq/24 hs	100-200 mEq/24 hs	200 mEq/24 hs	
SBP	120 mmHg	Male	0	2	1
		Female	4	24	3
	120 mmHg	Male	2	24	5
		Female	2	2	0
DBP	80 mmHg	Male	0	7	4
		Female	5	19	3
	80 mmHg	Male	2	19	2
		Female	1	7	0
MBP	93 mmHg	Male	0	5	3
		Female	6	24	3
	93 mmHg	Male	2	21	3
		Female	0	2	0

Figure 3. Scatter plots showing the relationship between SBP and natriuria. $p = 0.6$ $r = 0.003$. DBP and natriuria. $p = 7$ $r = 0.002$.



supports studies that show a direct relationship between a higher salt intake and an increase in cardiovascular events. Starzullo *et al.* showed that increasing salt consumption by 5 grams per day led to a 17% increased risk for cardiovascular events.¹⁰ Sacks *et al.* also established that a combination of low levels of sodium consumption (below 100 mmol/day) and the DASH diet could significantly reduce blood pressure.¹¹

Fortunately, none of the subjects in the study were found to have stage II hypertension. This is possibly related to the age group of the subjects, as the prevalence of hypertension increases progressively with age.¹²

Only 7% of those studied consumed less than 5 grams of salt per day and the mean intake of salt was 9.4 grams per day. This finding is comparable to the study of Salt Intake Around The World,¹³ in which the mean sodium intake of most adult populations was greater than 100 mmol per day (6 grams per day). For many countries, especially those in Asia, sodium intake was greater than 200 mmol per day (12 grams per day). All populations in that study were found to exceed the recommended salt intake of between 5 and 6 grams per day.¹⁴⁻¹⁶ The first report on U.S. dietary goals by the Senate Committee for Nutrition and Human Needs initially recommended a maximum of 3 grams of sodium chloride per day (52 mmol of sodium),¹⁷ but concerns about the feasibility of achieving this goal lead to a revision of their recommendation to a maximum of 5 grams of sodium chloride per day.¹⁵

Regarding the addition of extra salt to food, we found that 40% of people who consume less than 5 grams of salt per day never add salt to their food and 60% do so only occasionally. Also 51% of those consuming 5-10 grams of salt per day and 47% who consume between 11-14 g/day never add extra salt to their food.

Therefore we can presume that most of the salt consumed comes from salt added during cooking, condiments or salt added by the food industry. An

additional factor is the high consumption of red meat in Paraguay, with most people in this study consuming meat more than 5 days per week. Vegetables and fruits which are low in sodium are expensive so individuals consume these in much smaller quantities.

On the other hand, in the group with the highest consumption of salt (greater than 14 grams per day), 43% sometimes added salt to their food and 29% always added salt. We think that this high consumption of salt can be related to the habit of adding extra salt to the food without even trying if the food has enough salt yet. However, 14% of this group never adds salt to their food, so again; the high consumption may be related to salt added during cooking and by the food industry.

As shown in several studies, when comparing diets based on natural foods *versus* those based on processed foods, processed-food diets tend to be high in sodium and low in potassium.^{18,19} Isolated populations that eat predominantly natural foods show the reverse pattern, with individual potassium intake exceeding 150 mmol per day and a sodium intake of only 20 to 40 mmol per day.¹⁹⁻²¹

In our study, the mean potassium excretion was 51.5 mEq/day.

Population studies have shown an inverse relationship between potassium intake and blood pressure, the prevalence of hypertension, and the risk of stroke.^{20,24-27}

Of the 73 people that participated in this study, 34 had a SBP less than 120 mmHg. The majority of these were female, concluding that females tend to have lower blood pressure.

Only 15.6% of the study subjects regularly engaged in physical activity, and we found that the MBP was significantly related to exercise. Physical activity, especially aerobic exercise, reduced blood pressure in both hypertensive and normotensive persons, consistent with conclusions in study conducted by Whelton *et al.*¹⁵

69.5% who had a MBP lower than 93 mmHg had inherited factors like first degree relatives with hypertension showing a significant relationship ($p = 0.031$), suggesting that these factors may not be as important in the young adults.

61% of those studied with a BMI greater than 25 had a MBP higher than 93 mmHg, showing a relationship between BMI and blood pressure.

The mean BMI in the study was 24.1, which is within to the superior normal level. Obesity and being

overweight are known risk factor for the development of hypertension.¹⁸

CONCLUSIONS

Forty-six percent of the young Paraguayans in this study had a SBP \geq 120 mmHg but \leq 139 mmHg, defined as prehypertension. Eighty percent of this prehypertensive population consumed between 5 and 14 grams of salt per day, in excess of the 5 g/day recommended. Three percent were found to have stage 1 hypertension, and all individuals within this group consumed more than 5 grams of salt per day. These findings are alarming in spite of the fact that the relationship between SBP and salt consumption did not reach statistical significance ($p = 0.6$, $r = 0.003$), as this is possibly due to the small sample size.

Only 7% of the group studied consumed less than 5 grams of salt per day. The mean intake of salt was 9.4 grams per day, and males had higher salt consumption ($p = 0.02$). These findings demonstrate the high amount of salt intake by young Paraguayans and the need to raise awareness.

Of the 72 people that participated in the study, 34 had a SBP less than 120 mmHg. The majority of these were female, concluding that females tend to have lower blood pressure ($p < 0.0001$). This shows the increased prevalence of high blood pressure in the other 35 volunteers, the majority of which were males.

This is the first study done in young Paraguayans concerning salt intake and blood pressure. Additional studies should be undertaken not only in the Paraguayan population but in all of South America, in order to draw further conclusions and to support implementation of the WASH campaign to improve public health, especially in the younger age groups, to prevent cardiovascular and renal diseases which are among the most common causes of death.

CONFLICT OF INTEREST

None of the authors have any conflict of interest to disclose.

ACKNOWLEDGMENTS

Special thanks to Professor Gustavo Rodriguez Andersen MD and Carlos Franco Palacios MD for their help with and collaboration on this paper, as well as Angeles Ojeda for helping with the sample collection.

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