Hypertension in Mexican adults: results from the National Health and Nutrition Survey 2006

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Barquera S, Campos-Nonato I, Hernández-Barrera L, Villalpando S, Rodríguez-Gilabert C, Durazo-Arvizú R, Aguilar-Salinas CA. Hypertension in Mexican adults: results from the National Health and Nutrition Survey 2006. Salud Publica Mex 2010;52 suppl 1:S63-S71.

Abstract

Objective. To describe the prevalence of hypertension among Mexican adults, and to compare to that observed among Mexican-Americans living in the US. **Material and Methods.** The primary data source came from adults (≥20 years) sampled (n=33 366) in the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006). Hypertension was defined when systolic blood pressure was ≥140 and/or diastolic was ≥90 or patients previously diagnosed. **Results**. A total of 43.2% of participants were classified as having hypertension. We found a positive statistically significant association ($p<0.05$) between hypertension and BMI, abdominal obesity, previous diagnosis of diabetes and hypercholesterolemia. Subjects with hypertension had a significantly higher odd of having a history of diabetes or hypercholesterolemia. Hypertension had a higher prevalence in Mexico than among Mexican-Americans living in the US. **Conclusions**. Hypertension is one of the most prevalent chronic diseases in Mexico. In the last six years in Mexico, a substantial increase (25%) has been observed in contrast to the reduction seen among Mexican-Americans (-15%).

Keywords: high blood pressure; obesity; type 2 diabetes; dyslipidemias; national surveys

Barquera S, Campos-Nonato I, Hernández-Barrera L, Villalpando S, Rodríguez-Gilabert C, Durazo-Arvizú R, Aguilar-Salinas CA. Hipertensión en adultos mexicanos: resultados de la Encuesta Nacional de Nutrición y Salud 2006. Salud Publica Mex 2010;52 supl 1:S63-S71.

Resumen

Objetivo. Describir la prevalencia de hipertensión arterial de adultos mexicanos y compararla con la observada en mexicanos residentes en Estados Unidos (EUA). **Material y métodos**. La principal fuente de información fue la muestra de adultos (≥20 años) que participaron en la Encuesta Nacional de Salud y Nutrición 2006 (ENSANUT 2006) (n=33 366). El diagnóstico de hipertensión se definió cuando la tensión arterial sistólica y/o diastólica fue ≥140/≥ 90 mmHg, o tenían diagnóstico médico previo. **Resultados**. El 43.2% tuvo diagnóstico de hipertensión. Se encontró una asociación positiva ($p<0.05$) entre hipertensión e índice de masa corporal (IMC), obesidad abdominal, diagnóstico previo de diabetes e hipercolesterolemia. Los hipertensos tuvieron una razón de momios mayor de tener antecedente de diabetes o hipercolesterolemia. La prevalencia de hipertensión fue mayor en México, que entre mexicanos residentes en EU. **Conclusiones**. La hipertensión es una de las enfermedades crónicas más frecuentes en México. En los últimos seis años se observó un incremento en la prevalencia en mexicanos (25%) en comparación con la reducción en la de mexicanos residentes en EUA (-15%).

Palabras clave: hipertensión arterial; obesidad; diabetes tipo 2; dislipidemias; encuestas nacionales

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Received on: January 12, 2010 • **Accepted on:** March 19, 2010
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Hypertension (HT) is one of the most important cardiovascular disease risk factors and one of the main cause of mortality in Mexico.[1] In 2000, the prevalence of hypertension was 26.4% among the global adult population [2,3] In Latin America it is estimated that approximately 35% of adults have HT.[4]

In the last two decades, a substantial increase in the prevalence of HT was observed in Mexico[5] from 25% in 1993[6] to 33.3% in 2000.[7] These figures raised concern in the medical sector, especially because approximately 61.1% of the population with hypertension were not aware of their condition, and only 29% of the participants with HT had an adequate control.[7]

Several risk factors for HT such as population ageing, poverty, cultural and educational characteristics, poor diets, lack of physical activity, high consumption of sodium, obesity, type 2 diabetes and dyslipidemias, have been identified in several studies as important contributors that can explain the unprecedented raise in this condition.[8-10] While chronic disease (e.g. HT) prevalence in Mexico was studied from the last two national surveys (1994 and 2000), there were many limitations, such as lack of power to disaggregate by country state or other socio-demographic factors.

This study aims to describe the frequency and distribution of HT in a representative sample of the adult Mexican population who participated in the National Health and Nutrition Survey 2006 (ENSANUT 2006*). It also analyzed the observed trends in the past 6 years and compared them with the ones of Mexican-Americans living in the US.

Material and Methods

The National Health and Nutrition Survey 2006

The ENSANUT 2006 was conducted between October 2005 and May 2006, with a probabilistic multistage stratified cluster sampling design. The survey was designed to update the prevalence of infectious and chronic diseases and their associated risk factors, with statistical power to detect prevalences ≥ 8% by state. A maximum relative error of 25% was set for the state estimators, with a confidence level of 95%, a non-response rate of 20% and a design effect of 1.7. With this information a sample size of at least 1476 households per state was required. A total of 47 152 households were visited, and from each one, a random selection was performed to interview the following subjects: a child (under age 10), an adolescent (ages eleven to nineteen years), and an adult (ages 20 years and older). The survey has the power to make distinctions between urban (≥2 500 inhabitants) and rural (<2 500 inhabitants) areas, and four geographic regions described below. The stratification of sampling units was made considering a maximum of six strata per state. Socio-demographic and personal health questionnaires, blood pressure and anthropometric measurements were obtained from all adult participants. Questionnaires were applied by trained health personnel. Self-reported health information including diverse conditions such as obesity, depression, accidents, type 2 diabetes, high blood pressure, cardiovascular diseases, and risk factors such as tobacco and alcohol consumption was collected. A detailed description of the sampling procedures and survey methodology has been published elsewhere.[11]

Sample weights for each participant were calculated in order to adjust for the complex sampling design taking into account the differences between age and gender distribution and national census information.[12]

Geographic regions

The ENSANUT 2006 and this biological subsample are representative of four regional strata, Northern, Central, Central-western and Southern. The four regional strata, with common geographic and socio economic characteristics, were 1) Northern: Baja California, Southern Baja California, Coahuila, Chihuahua, Nuevo Leon, Sonora, Sinaloa and Tamaulipas, 2) Central: Distrito Federal, Hidalgo, Estado de México, Morelos, Puebla, Queretaro and Tlaxcala, 3) Central-western: Aguascalientes, Colima, Durango, Guanajuato, Jalisco, Michoacan, Nayarit, San Luis Potosi and Zacatecas, and 4) Southern: Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz and Yucatan). This regionalization scheme has been used in diverse epidemiologic transition analysis for within country comparisons.[13,14]

Construction of the socio-economic status index

A principal components analysis (PCA) was performed on household characteristics (flooring material, ceiling, walls, water source, sewerage, number of persons residing in the household and number of domestic appliances). The main factor extracted explained 40.4% of the total variance with a Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy= 0.83 and was used as a proxy of socioeconomic status (SES). This factor had large loadings for household and community characteristics such as sewer system, indoor plumbing, refrigerator and television. Small loadings were observed

* From the spanish acronym: Encuesta Nacional de Salud y Nutrición 2006.

for variables such as communal food distribution and number of people residing in the household. This factor was divided into tertiles and used as a proxy for low, medium and high socio-economic level.

Anthropometric measurements

Following internationally accepted techniques, standardized personnel measured height to the nearest 0.1 cm using a stadiometer; and body weight using a digital scale with an error of 5 mm and 0.1 kg, respectively. Waist circumference (WC) was measured at the mid point between the highest part of the iliac crest and the lowest part of the ribs margin of the median axial line. If WC was ≥90cm in males or ≥80cm in females, the subjects were classified as having abdominal adiposity based on the International Diabetes Federation criteria.[16] Body mass index (BMI) was calculated by dividing the weight in kilograms by height in meters squared; and categorized according to the World Health Organization (WHO) cut-off points into: low weight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2) and obesity (≥30 kg/m^2).[15]

Blood pressure measurements

Blood pressure was measured twice by a trained nurse in the dominant arm using a mercury sphygmomanometer on two different visits. The first reading was carried out after at least five minutes of rest seated. The second reading was taken five minutes apart from the first. The first Korotkoff sound marked the systolic blood pressure and the fifth sound the diastolic blood pressure. Hypertension was defined as having a systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg on the first reading, and confirmed by the second reading as recommended in the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure,[17] or when participants self-reported a previous HT diagnosis by a physician.

Other socio-demographic variables

Education was stratified into three groups: 1) primary school or less, 2) middle school and 3) high school education or higher.

Comparison between trends in Mexico and United States

We compared the prevalence of hypertension with the one obtained from the previous Mexican Health Survey (2000), and with the reported prevalence of hypertensive adults born in Mexico and living in the United States (i.e. Mexican-Americans) from National Health and Nutrition Examination survey (NHANES) in 1999-2000[18] and 2005-2006.[19]

Statistical analysis

The blood pressure data was cleaned of aberrant values (n=55). Blood pressure categories (normal and hypertension) were created for the complete sample and stratified according to the following socio-demographic factors and health characteristics: sex, age group, country region and location, socio-economic status, education, body mass index, abdominal obesity and two previously diagnosed chronic conditions (type 2 diabetes and hypercholesterolemia). Treatment characteristics were categorized by current and pharmacological treatment, time of diagnosis, complementary treatments, and institution where medical care was provided. For women we also evaluated history of preeclampsia. The prevalence of hypertension was also estimated by state and ranked by order of magnitude.

Four multivariate logistic regression models were constructed to assess the strength of the association between having a previously diagnosed chronic condition (type 2 diabetes or hypercholesterolemia) and systolic hypertension (blood pressure ≥140 mmHg) or diastolic hypertension (blood pressure ≥100 mmHg). Models were adjusted for sex and age. Multivariate analysis was also performed to explore changes in the prevalence of hypertension due to interactions between age and sex in an attempt to evaluate endocrine effects, particularly in menopausal women.

To make comparisons between Mexico and United States, all participants were divided into hypertensive or normotensive groups. Among the hypertensive individuals it was determined whether they were previously aware of the condition. Control status was defined among treated hypertensive cases based on whether the measured BP was ≥140/90 mmHg. Age-adjustment was done using the direct method, with 5-year age groups derived from the 2005 Mexican census. To have nationally representative analyses, sample weights provided for each survey were used to generate the summary tables of prevalence.

All analyses were adjusted for the complex multistage survey design using the "SVY" module of STATA 8.2.* Between group diffences were analyzed comparing the prevalence and 95% confidence intervals (95%CI) by

* Stata Corporation. Stata reference manual. Release 9., vol. 1-4. College Station, TX, USA: Stata Press; 2007.

a Pearson χ^2 test for categorical variables. Continuous variables were described using means and standard error (SE) and compared across categories using analysis of variance (ANOVA). Statistical significance was assessed at *p*-value <0.05.

Ethical Considerations

An informed consent letter was signed by all participants after explaining the nature, objectives and risks inherent to the study. The protocol was approved by the Research, Ethics and Biosecurity committees of the Mexican National Institute of Public Health. Researchers took provisions for maintaining the confidentiality of the data collected and to protect the rights stipulated by the Mexican Statistical and Geographic information law. [20]

Results

The final analytic sample was comprised of 33 366 individuals (55.6% females). A total of 55 cases (0.16%) were excluded from the analysis because of incomplete or aberrant data. Table I summarizes the socio-demographic characteristics, anthropometry and previously diagnosed chronic diseases in hypertense participants, disaggregating them by those that were survey finding and the ones previously diagnosed. A total of 43.2% (n=14 630) of the population was classified as having HT. Most of them were unaware of their condition (62%). There were significant positive associations between having HT and the following variables: sex, age, BMI, abdominal obesity and a previous diagnosis of type 2 diabetes or hipercolesterolemia. There were no statistical significant differences among regions, urban or rural areas, or socioeconomic status. However, we found a negative statistical significant association (p<0.05) between HT and education level.

Table II summarizes characteristics of HT treatment among those previously diagnosed with HT. A total of 15.4% (n=7 005) of the hypertensive population was receiving medical treatment. From this subgroup, more than 58% have received 3 or less years of treatment and only 22.1% had received more than 10 years. Among those on medical treatment, 61.0% were on pharmacotherapy. Blood pressure was monitored weekly in 13.2% of the survey participants, 54.0% received monthly, and 32.8% received yearly monitoring. The most frequent complementary therapy was a dietary plan (16.2%). Most of the participants received their medical care from the Mexican Institute of Social Security (41.7%), followed by the Ministry of Health (MOH) clinics and the "Seguro Popular" (a MOH free insurance for vulnerable groups) (25.4%). Very few participants attended private institutions (4.8%).

The mean systolic blood pressure was 122 mmHg (95% *CI* 121.6-122.3 mmHg) while the mean diastolic blood pressure was 77.9 mmHg (95% *CI* 77.7-78.2 mmHg). Systolic and diastolic blood pressure significantly increased with age, BMI, and decreased as education level increased. No significant differences were found among geographic regions, socioeconomic status or urban and rural areas (Table III).

The prevalence of hypertension was higher in the northern states [Sonora, Durango, Sinaloa, Tamaulipas Baja California, Baja California Sur, Coahuila (range 58.4-48.2%)], compared to Southern States as such Guerrero, Oaxaca, Chiapas (range 39.6-37.4%), the lowest prevalence was registered in the state of Morelos (34.4%). Yucatan, a southern state, was the exception in this region showing prevalences similar to those observed in the northern states (48.8%) (Figure 1).

The sex and age-adjusted odd ratios (OR) for subjects with systolic hypertension were significantly higher for having a history of type 2 diabetes (*OR*=1.47, p<0.05) or hypercholesterolemia (*OR*=1.25, p<0.05). This pattern was also observed with diastolic blood pressure (data not shown).

When HT prevalence trends from 2000 to 2006 were compared between Mexicans and Mexicans living in the US (Mexican-Americans), a reduction of 19.9 to 17% was observed in Mexican-American females and 19.1 to 16.1% in Mexican-American males from US. In contrast, Mexican females and males experienced an increase in HT prevalences over the same period, 34.7 to 47.3% and 35.4 to 40.3% respectively (Figure 2).

Discussion

In the last two decades, the prevalence of HT has increased from 23.8% in 1993 to 30.7% in 2000 in Mexico. In this study using the nationally representative ENSANUT 2006 we found that HT prevalence had risen to 43.2% in 2006. This significant increase could be partially explained by the aging of the population and the unprecedented raise in overweight, obesity[21] and type 2 diabetes observed in the country.[22,23] However, some very important contributing factors have not been adequately investigated in Mexico, such as the sodium consumption, particularly sodium from industrialized foods that could be easily reduced through diverse mechanisms.

The minority of hypertensives in Mexico (26.6%) were not aware of their condition. This reflects a challenge for the Mexican health system in terms of

Table I

SOCIO-DEMOGRAPHIC CHARACTERISTICS, ANTHROPOMETRY AND PREVIOUSLY DIAGNOSED CHRONIC DISEASES IN ADULTS ≥ 20 YEARS WITH HYPERTENSION. MEXICO, ENSANUT 2006*

	Hypertension‡			*Survey finding*			*Previously diagnosed*		
	%	*95% CI*	*n*	*%*	*95% CI*	*n*	*%*	*95% CI*	*n*
Total	43.2	42.2 - 44.1	14,630	26.7	25.8 - 27.5	9,224	16.5	15.8 - 17.2	5,406
Sex[&]									
Females	47.3	39.2 - 41.4	8,315	34.7	33.5 - 36	4,486	12.6	11.7 - 13.5	3,829
Males	40.3	45.9 - 48.8	6,315	21.0	20.1 - 21.9	4,738	19.3	18.3 - 20.2	1,577
Age (years)[&]									
20-29	23.0	21.5 - 24.5	1,762	16.6	15.3 - 17.9	1,262	6.4	5.6 - 7.2	500
30-39	32.7	31.1 - 34.2	3,034	22.8	21.4 - 24.2	2,145	9.9	8.8 - 10.9	889
40-49	43.2	41.3 - 45.2	3,059	27.9	26.3 - 29.5	2,011	15.3	14.1 - 16.6	1,048
50-59	60.3	58 - 62.5	2,546	35.5	33.3 - 37.8	1,517	24.8	22.7 - 26.8	1,029
≥60	72.8	71.1 - 74.5	4,224	37.9	35.9 - 39.9	2,287	34.9	32.8 - 37	1,937
Body mass index[&] (kg/m^2)[§]									
Normal	30.4	28.9 – 32.0	2,882	20.6	19.3 - 22	1,989	9.8	8.9 - 10.8	893
Overweight	42.7	41.2 - 44.2	5,576	27.1	25.9 - 28.4	3,656	15.6	14.4 - 16.7	1,920
Obesity	57.8	56.3 - 59.1	5,799	32.8	31.5 - 34	3,341	25.0	23.7 - 26.3	2,458
Abdominal obesity[#,&]									
Yes	48.8	47.8 - 49.9	12,151	28.7	27.8 - 29.7	7,363	20.1	19.2 - 20.9	4,788
No	27.6	26.1 - 29.2	2,156	21.1	19.7 - 22.6	1,649	6.5	5.7 - 7.3	507
Region[&]									
Northern	47.4	45.6 - 49.1	3,718	30.5	29.0 - 32.0	2,375	16.9	15.8 – 18.1	1,343
Central	40.1	38.1 - 42.1	2,856	22.6	21.1 - 24.1	1,761	17.5	15.9 – 19.0	1,095
Center/West	44.5	42.8 - 46.1	4,428	26.5	25.1- 27.8	2,618	18.0	16.7 – 19.2	1,810
Southern	42.6	40.8 - 44.5	3,628	29.2	27.4 - 30.9	2,470	13.4	12.4 – 14.5	1,158
Area[&]									
Rural	44.4	42.6 - 46.1	4,319	31	29.4 - 32.5	2,910	13.4	12.3 - 14.5	1,409
Urban	42.9	41.7 - 44	10,311	25.4	24.4 - 26.3	6,314	17.5	16.7 - 18.3	3,997
Socioeconomic status tertile[&]									
Low	43.4	42 - 44.8	5,594	29.3	28.1 - 30.6	3,751	14.1	13.1 - 15.1	1,843
Medium	43.6	42.1 - 45.1	5,127	26.3	25.1 - 27.6	3,159	17.3	16.1 - 18.5	1,968
High	42.5	40.8 - 44	3,844	24.3	22.9 - 25.6	2,268	18.2	17 - 19.4	1,576
Education[&]									
Primary school or less	59.0	56.8 - 61.4	2,162	35.7	33.5 - 38	1,340	23.3	20.9 - 25.8	822
Middle school	48.0	46.7 - 49.2	7,846	28.5	27.4 - 29.6	4,718	19.5	18.5 - 20.5	3,128
High school or more	33.8	32.4 - 35.2	4,560	22.2	21.1 - 23.4	3,119	11.6	10.7 - 12.5	1,441
Previously diagnosed type 2 diabetes[&]									
Yes	69.1	66.1 - 72.1	1,593	31.6	28.6 - 34.7	702	37.5	34.3 - 40.7	891
No	41.2	40.2 - 42.1	13,015	26.3	25.4 - 27.1	8,508	14.9	14.2 - 15.5	4,507
Previously diagnosed hipercolesterolemia[&]									
Yes	65.0	62.3 - 67.6	2,008	23.1	20.8 - 25.3	725	41.9	39.3 - 44.5	1,283
No	40.7	39.8 - 41.7	12,468	27.1	26.2 - 28	8,398	13.6	13 - 14.3	4,070

* Data adjusted for the complex survey design. Cases analyzed if had blood pressure recorded and information on previous diagnosis.

‡ Seventh Report of the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure cut-off points. SBP ≥140 o DBP ≥90 mmHg or pharmacological treatment for hypertension.

§ WHO cut-off points. BMI normal = 18.5-24.9 kg/m^2, overweight 25.0-29.9 kg/m2, obesity ≥30 kg/m^2.

Abdominal obesity cut-off points by International Diabetes Federation criteria (≥80 cm females, ≥90 cm males).

& Statistically significant different between categories using a Pearson χ^2 test ($p<0.05$)

Table II
CHARACTERISTICS OF TREATMENT FOR HYPERTENSION IN ADULTS ≥ 20 YEARS. MEXICO, ENSANUT 2006‡

	Previous medical diagnosis		
	%	*95% CI*	*n*
Duration of hypertension (years)*			
< 1	27.5	25.5 - 29.5	1,513
1 to 3	30.6	28.5 - 32.7	1,629
4 to 10	19.7	18.1 - 21.4	1,047
More than 10	22.1	20.2 - 24.1	1,157
Pharmacological treatment			
Yes	61.0	58.7 - 63.3	3,118
How often do you measure your blood pressure*			
Weekly	13.2	11.5 - 14.9	558
Monthly	54.0	51.7 - 56.3	2,641
Yearly	32.8	30.6 - 34.9	1,532
Lifestyle measures to control hypertension			
Dietary plan	16.2	14.6 - 17.7	785
Exercise	4.1	3.4 - 4.9	225
Homeopathy	0.9	0.4 - 1.3	45
Herbal	1.6	1.1 - 2.1	97
Reduction in salt consumption	4.3	3.5 - 5.1	218
Other	1.6	1.1 - 2.1	85
Institution providing medical care*			
IMSS§	41.7	39.0 - 44.4	1,231
Health Ministry (SSA)#	20.4	18.2 - 22.5	753
Seguro popular (SSA)&	5.0	3.9 - 6.0	245
ISSSTE≠	6.4	5.2 - 7.6	213
Other institutions	21.7	19.4 - 24.0	546
Private	4.8	3.3 - 6.3	116
History of preclampsia∞			
Yes	16.6	14.8 - 18.3	661
No	83.4	81.7 - 85.2	3168

* Statistically significant different using a Pearson χ^2 test ($p<0.05$)
‡ Data adjusted for the complex survey design. Cases analyzed if had information of previously diagnosed
§ Mexican Institute of Social Security
# Health Ministry System
& People's Public National Insurance
≠ Institute for Social and Health Security of State Employees
∞ Among women with hypertension who reported at last one pregnancy

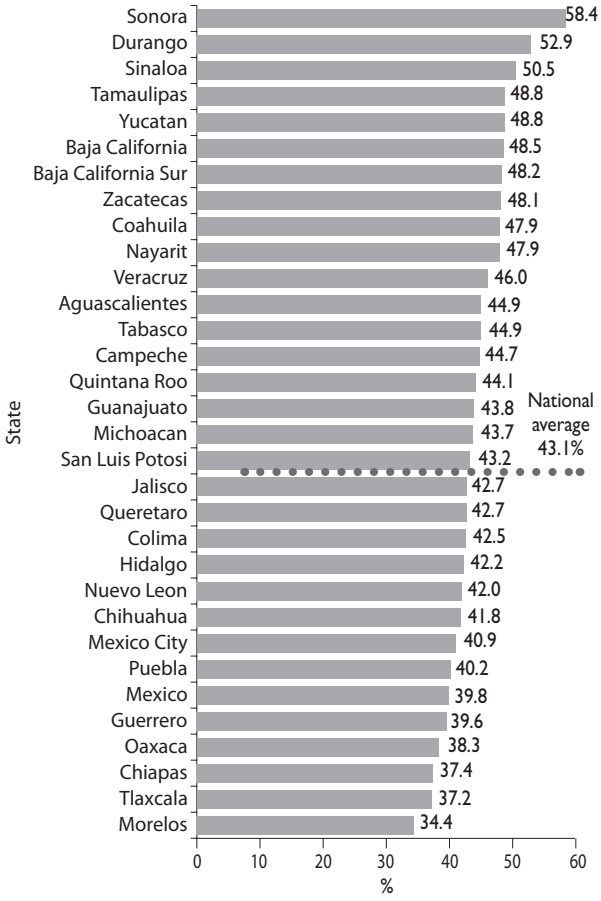
promoting education and early diagnosis of chronic conditions among adults as well as proper HT treatment and control. Only 56.8% of those with HT had their blood pressure under control.

Hypertension is more prevalent in Mexico than among Mexican-Americans living in the United States, and the increasing trend in HT prevalence observed in Mexican over the last 6 years is contrary to the reduction observed among Mexican-Americans. The reasons for this paradoxical observation are not known but it has been recognized that treatment and control of this condition is considerably less advanced in Mexico. The large-scale migration to the United States from Mexico presents a series of important challenges as well as opportunities for public health in both countries. We compared large, nationally representative surveys of hypertension and related risk factors in Mexicans and Mexican-Americans.[21] Data from the National Health and Nutrition Examination survey (NHANES/NCHS) between 1999-2006 in USA, showed that 71.8% of the

Table III
MEANS VALUES OF SYSTOLIC AND DIASTOLIC BLOOD PRESSURE BY BMI, AGE AND SOCIO-DEMOGRAPHIC FACTORS. MEXICO, ENSANUT 2006*

	Systolic blood pressure (mmHg)		*Diastolic blood pressure (mmHg)*	
	TOTAL		*TOTAL*	
	Mean	*95% CI*	*Mean*	*95% CI*
TOTAL	122		77.9	77.7 - 78.2
* Sex				
Females	120.7	120.4 - 120.9	76.9	76.7 - 77.1
Males	124.8	124.5 - 125.1	79.9	79.7 - 80.0
Age group (years)‡				
20-29.9	114.6	114.1 - 115.1	74.3	73.9 - 74.6
30-39.9	117.4	116.9 - 117.8	76.7	76.3 - 77.0
40-49.9	121.8	121.2 - 122.4	79	78.5 - 79.4
50-59.9	128.2	127.4 - 129.0	81.6	81.0 - 82.1
≥ 60	133.9	133.4 - 134.9	80.9	80.3 - 81.4
p for trend	*<0.0001*		<0.0001	
Body Mass Index group‡				
Normal	117.7	117.2 - 118.2	74.7	74.4 - 75.1
Overweight	122.3	121.8 - 122.7	78.1	77.8 - 78.5
Obesity	126.4	125.9 - 126.9	81.2	80.9 - 81.6
p for trend	*<0.0001*		<0.0001	
Region				
Northern	123.2	122.6 - 123.8	78.8	78.4 - 79.3
Central	120.6	120.0 - 121.3	77.4	76.8 - 77.9
Center/West	122.5	121.9 - 123.1	78.5	78.1 - 79.0
Southern	122.4	121.7 - 123.1	77.5	77.0 - 78.0
Area‡				
Rural	123.2	122.6 - 123.9	78.3	77.9 - 78.8
Urban	121.6	121.2 - 122.0	77.8	77.5 - 78.1
P for trend	*<0.0001*		0.049	
Socioeconomic status tertile				
Low	122.5	122.0 -123.0	77.8	77.3 - 78.1
Medium	121.9	121.4 - 122.5	78.1	77.6 - 78.4
High	121.5	121.0 - 122.1	78.2	77.7 - 78.5
p for trend	*0.612*		0.001	
Education‡				
Primary school or less	128.8	127.9 - 129.8	79.3	78.7 - 79.9
Middle school	123.6	123.2 - 124.1	78.7	78.4 - 79.0
High school or more	118.4	118.0 - 118.8	76.8	76.4 - 77.1
p for trend	*<0.0001*		<0.0001	

* Data adjusted for the survey complex design
‡ Statistically significant different using a ANOVA χ^2 test ($p<0.05$)
C.I. = Confidence interval



* Data adjusted for the survey complex design

Figure 1. Prevalence of hypertension in Mexican adults by state. Mexico, ENSANUT 2006*

adults are aware they are hypertensive, 61.4% are currently taking an antihypertensive drug therapy, and 35.1% have their blood pressure under control (less than 140/90 mmHg). Mexican-Americans have a lower percentage of their blood pressure under control (26.5%), compared to Non-Hispanic whites (35.4%) and Non-Hispanic blacks (28.9%).[24]

Increasing age group and BMI category was two of the main correlates to HT as in other studies. In addition, those with HT were more likely to have a previous diagnosis of type 2 diabetes or dyslipidemias, suggesting that these conditions are more commonly clustered as metabolic syndrome. When stratifying by sex, we found a higher prevalence of HT in women than men (47.3% *vs* 40.3% $p<0.05$ respectively). Differences between gender have multiple possible causes such as hormonal and endocrine differences between sexes.[25,26] We modeled the ORs for HT for women older than 45 years of age, to explore the possible role of menopause and found a higher prevalence than in younger women and similar to men (*OR*=2.7, 95% *CI* 2.6 to 2.9) (data not shown). These result was similar to the ones obtained in the previous Mexican Survey of 2000.[22] Our data are similar to those found in the American population, where the prevalence of hypertension is higher in men younger than 45 years of age, then similar from 45-54 years and then is greater in women than in men.[27]

The inverse association between education and HT suggests that the least educated population has unequal access to preventive and health attention services. The current "Seguro Popular" (free-universal insurance for the previously un-insured vulnerable population) could be a powerful mechanism to improve early diagnosis and treatment as well as adherence and control in the

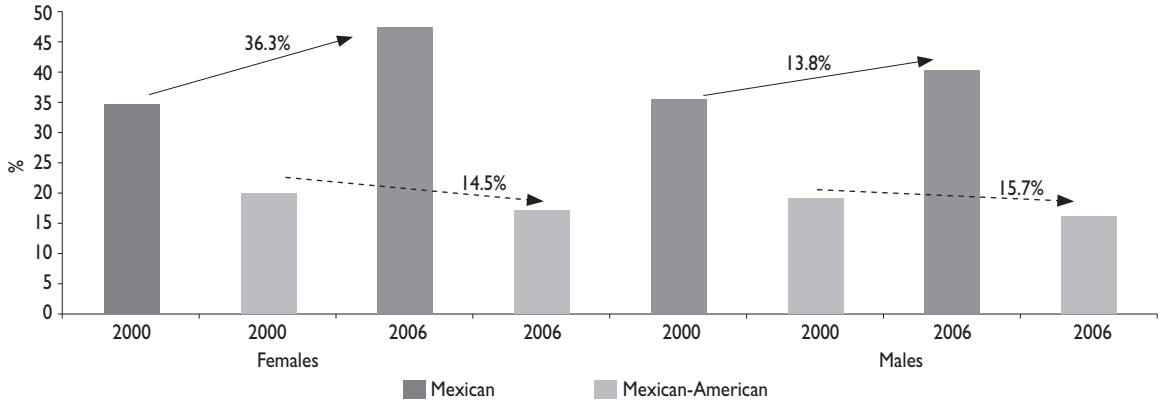


Figure 2. Changes in the prevalence of hypertension in Mexican adults (MHS 2000, ENSANUT 2006 and NHANES 1999-2000, NHANES 2005-2006)

least educated and poor populations. Thus, the coverage of this government strategy must target the marginal groups and initiate prevention programs focused not only in undernutrition and pre-transition health problems (such as infections and maternal and child health) but also in increasing the knowledge and prevention of non-communicable chronic conditions such as high blood pressure. Rapid increases in diverse non-communicable chronic diseases and their related risk factors are taking place in Mexico. There is an important need to develop more detailed information and to prioritize public health programs towards prevention and early diagnosis and treatment of these conditions to ameliorate the current burdens and increasing prevalences of cardiovascular disease and type 2 diabetes.

Acknowledgments

We would like to thank the support of Cuichan Cao, MS (Loyola University), and Kanter R, PhD (Johns Hopkins Bloomberg School of Public Health) for their collaboration in the preparation of this report. In addition we would like to acknowledge an unrestricted grant from Sanofi-Aventis that made possible this study.

Conflicts of interest

We declare that we have no conflicts of interest.

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