Prevalence of Hypertension and Associated Risk Factors in Six Nicaraguan Communities

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Objective: Describe the prevalence of hypertension.

Design: Population based cross-sectional survey.

Setting: Six Nicaraguan communities with varying economies.

Participants: 1,355 adults aged 20–60 years who completed both self-reported and quantitative measures of health.

Main Outcome Measures: Prevalence of hypertension (systolic ≥140 mm Hg, diastolic ≥90 mm Hg, or self-reported medical history with diagnosis by a health care professional), uncontrolled hypertension (systolic ≥140 mm Hg or diastolic ≥ 90 mm Hg), diabetes (urinary glucose excretion ≥100 mg/dL or self-reported medical history diagnosed by a health care professional), and uncontrolled diabetes (urinary glucose excretion ≥100 mg/dL only).

Results: The prevalence of hypertension was 22.0% (19.2% in men, 24.2% in women). Blood pressure was controlled in 31.0% of male hypertensives and 55.1% of female hypertensives (odds ratio [OR] 2.86; 95% confidence interval [CI] 1.74–4.69). Older age and higher body mass index were strongly associated with hypertension. Women who completed primary school had a lower risk of hypertension (OR .40; 95% CI .19–.85) compared to those with no formal education. A history of living in both urban and rural settings was associated with lower prevalence of hypertension (OR .52; 95% CI .34–.79). Diabetes mellitus was found in 1.2% of men and 4.3% of women. Male sex was independently associated with decreased risk of diabetes (OR .31; 95% CI .11–.86).

Conclusions: At least one cardiovascular risk factor was found in half of this Nicaraguan sample. Cardiovascular risk factors should be the target of educational efforts, screening, and treatment. (*Ethn Dis.* 2012;22(2):129–135)

Key Words: Cardiovascular Risk Factors, Central America, Developing Nations, Diabetes, Hypertension, Nicaragua, Noncommunicable Diseases

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Introduction

The prevalence of noncommunicable diseases like hypertension and diabetes continue rising in developing nations.[1] These diseases affect younger individuals[2] in settings where less health care infrastructure often leads to poorer control of these chronic conditions.[3]

Studies of noncommunicable diseases in Latin America have largely focused on urban populations and upper middle income countries.[4–14] Previous research demonstrates many established cardiovascular disease risk factors in Latin America: aging, hypertension (HTN), diabetes (DM)/insulin resistance, obesity, dyslipidemia, inactivity, poor diet, and tobacco smoking.[4–9,15,16] Men generally demonstrate lower levels of awareness, treatment and control of cardiovascular risk factors[17] and smoke more[18] while women are more obese.[19] Higher education and (sometimes) increasing wealth have correlated with lower prevalence of disease.[20–22]

Less is known about hypertension and diabetes in Latin America's lower middle income nations, especially among rural populations. Previous studies have demonstrated both cost-effective treatment of noncommunicable diseases in resource poor settings[23] and also the potential for economic consequences of treatment without effective prevention in developing economies.[24] Therefore, we set out to describe the prevalence of hypertension and diabetes in one urban and five rural communities given Nicaragua's status as a low middle income nation, previous research demonstrating poor health/dietary decisions among rural Central Americans,[25,26] and the availability, via rural clinics, of some hypertension and diabetes medications.

Methods

Setting and Study Population

Five communities in northwest (León and Chinandega departments) and one community in central Nicaragua (Matagalpa department) were selected representing distinct economies. Data were collected from September 2007 to July 2009. All men and women in these communities aged 20–60 years old were eligible to participate. The study was approved by the Bioethics Committee at UNAN-León. All participants were consented for study procedures.

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Variables, Data Sources, and Measurements

Participants were contacted in their homes and, if not there, were revisited at the end of data collection. Trained university medical personnel with community representatives performed a census in each community. A questionnaire covering demographic information, lifestyle, diseases, and medications was administered to establish the prevalence of various noncommunicable disease risk factors outlined in the CARMEN publication of the Pan-American Health Organization.[27]

Subsequently, participants went to a mobile laboratory. Blood pressure was measured using a calibrated M7 sphygmomanometer (Omron, Kyoto, Japan) after five minutes of quiet, seated rest. Weight and height were recorded barefoot using a calibrated clinical weight scale and measuring tape, respectively.

Participants provided a random urine sample (50 mL) in a sterile collector. Two study personnel tested each urine sample for glucosuria (glucose levels ≥100 mg/dL) and three degrees of proteinuria (None = Negative - trace; microalbuminuria = 30(+)–100(++) mg/dL; macroalbuminuria ≥ 300(+++ or ++++) mg/dL) using urine dipsticks (Bayer's Multistix, Leverkusen, Germany; Sensitivity 97%, Specificity 62%).[28]

Participants from five communities provided blood samples. These samples were stored at −20° C at UNAN-León and transported to the Nicaraguan Health Department's National Laboratory (MINSA, Managua, Nicaragua) where creatinine was measured using the Jaffe compensated method. In one community, creatinine levels were measured with capillary finger sticks using the StatSensor device (Nova BioMedical, Waltham, MA; Sensitivity 59%, Specificity 88%).[29] Glomerular filtration rate (GFR) of each participant was calculated using the MDRD equation.[30] The GFR was used to characterize the kidney function of each participant by chronic kidney disease stage.[31]

Table 1. Demographic characteristics of study participants in six Nicaraguan communities

Variable	Overall, *n* (%)	HTN, *n* (%)	DM, *n* (%)
All participants	1,355 (100)	298 (22.0)	40 (3.0)
Sex			
Men	589 (43.5)	113 (37.9)	7 (17.5)
Women	766 (56.5)	185 (62.1)	33 (82.5)
Age, years			
20–29	543 (40.1)	68 (22.8)	3 (7.5)
30–39	379 (28.0)	76 (25.5)	6 (15.0)
40–49	272 (20.1)	88 (29.5)	17 (42.5)
50–60	161 (11.8)	66 (22.1)	14 (35.0)
BMI (kg/m^2)			
<18.5	33 (2.4)	4 (1.3)	1 (2.5)
18.5–25.0	576 (42.5)	88 (29.5)	8 (20.0)
25.0–30.0	448 (33.1)	101 (33.9)	18 (45.0)
≥30	298 (22.0)	105 (35.2)	13 (32.5)
Presence of CKD[a]			
No CKD	820 (63.5)	192 (66.9)	23 (62.2)
Stage I–II	399 (30.9)	77 (26.8)	11 (29.7)
Stage III–V	72 (5.6)	18 (6.3)	3 (8.1)
Presence of proteinuria (≥+)[a]	240 (18.5)	57 (19.9)	9 (24.3)
Ever attended school			
No	269 (19.9)	86 (28.9)	14 (35.0)
Yes	1,086 (80.1)	212 (71.1)	26 (65.0)
Years of education[a]			
No formal education	268 (19.9)	86 (29.2)	14 (35.0)
Primary incomplete	516 (38.3)	113 (38.3)	14 (35.0)
Primary complete	235 (17.5)	43 (14.6)	5 (12.5)
Secondary incomplete	207 (15.4)	33 (11.2)	4 (10.0)
Secondary complete	59 (4.4)	12 (4.1)	1 (2.5)
Higher education	61 (4.5)	8 (2.7)	2 (5.0)
Income/dependent/day (USD)[a]			
<$1/day	434 (52.7)	90 (48.4)	12 (50.0)
$1–2/day	270 (32.8)	66 (35.5)	9 (37.5)
>$2/day	120 (14.6)	30 (16.1)	3 (12.5)
Residency – urban[a]			
Never	735 (67.6)	173 (72.7)	22 (73.3)
Sometimes	233 (21.4)	38 (16.0)	5 (16.7)
Always	120 (11.0)	27 (9.8)	3 (10.0)
Family history			
HTN	609 (44.9)	156 (52.3)	24 (60.0)
DM	220 (16.2)	64 (21.5)	18 (45.0)
CKD[a]	170 (12.6)	45 (15.1)	9 (22.5)
Smoking	424 (31.3)	97 (32.6)	11 (27.5)
Alcohol	647 (47.7)	152 (51.0)	15 (37.5)
Drugs (illicit)	69 (5.1)	12 (4.0)	0 (0)
Coffee drinking[a]	845 (62.7)	208 (70.0)	32 (80.0)

[a] These categories have <1,355 participants due to variations in participant responses. Response rates were >95% for presence of CKD, presence of proteinuria, years of education, family history (CKD) and coffee drinking. Some participants choose not to answer income questions (824 total responses) and in one of five villages residency history was not asked (1,088 total responses).

HTN, hypertension; DM, diabetes; BMI, body mass index; CKD, chronic kidney disease; USD, United States dollars.

Table 2. Characteristics of normotensives and hypertensives

Variable	Normotensives	Hypertensives
Mean age, years	33.1 (10.3)	39.7 (11.2)
Mean blood pressure, mm Hg		
Systolic	115.6 (11.8)	134.0 (21.3)
Diastolic	71.0 (7.8)	81.0 (12.6)
Mean BMI	26.0 (6.2)	28.3 (6.0)
Mean schooling, years	4.9 (4.0)	3.7 (3.6)
Mean income/dependent/day, USD	2.3 (25.7)	1.3 (1.0)
Sex		
Men	476 (45.0%)	113 (37.9%)
Women	581 (55.0%)	185 (62.1%)
Diabetes	17 (1.6%)	23 (7.7%)
Glucosuria	9 (.9%)	8 (2.7%)
Residency – urban		
Never	562 (66.1%)	173 (72.7%)
Sometimes	195 (22.9%)	38 (16.0%)
Always	93 (10.9%)	27 (11.3%)
Family history		
HTN	453 (42.9%)	156 (52.3%)
DM	156 (14.8%)	64 (21.5%)
CKD	125 (11.8%)	45 (15.1%)
Smoking – ever	327 (30.9%)	97 (32.6%)
Alcohol – ever	495 (46.8%)	152 (51.0%)
Drugs - ever	57 (5.4%)	12 (4.0%)
Coffee drinking	637 (60.6%)	208 (70.0%)

Data reported as *n* (%) or mean (standard deviation).

BMI, body mass index; USD, United States dollars; HTN, hypertension; DM, diabetes; CKD, chronic kidney disease.

Hypertension was defined as either systolic blood pressure ≥140 mm Hg, diastolic pressure ≥ 90 mm Hg, or self-reported medical history with diagnosis by a health care professional. Uncontrolled HTN was defined solely as a systolic blood pressure ≥ 140 mmHg or diastolic pressure ≥ 90 mm Hg. Hypertension was classified as: preHTN = systolic pressure 120–139 mm Hg or diastolic pressure 80–89 mm Hg; stage 1 HTN = systolic pressure 140–159 mm Hg or diastolic pressure 90–99 mm Hg; stage 2 HTN = systolic pressure ≥160 mm Hg or diastolic pressure ≥ 100 mm Hg.

Diabetes mellitus was defined as glucosuria (glucose excretion ≥100 mg/dL) or self-reported medical history of diabetes mellitus diagnosed by a health care professional. Uncontrolled diabetes mellitus was defined solely as glucosuria (glucose excretion ≥ 100 mg/dL). Overweight was defined as body mass index ≥ 25 kg/m^2 and obesity ≥30 kg/m^2.

Statistics

The data were initially examined using descriptive statistics including frequency distributions, mean, and standard deviation. Bivariate analyses were conducted to examine associations between dichotomous independent and dependent variables. Logistic regression models were used to provide an estimate of the independent relationship between covariates and the outcomes of interest. Those variables demonstrating significance with $P<.05$ were placed into multiple logistic regression models to calculate adjusted odds ratios. All variables were entered simultaneously into the models. Education was classified based upon the Nicaraguan school system: no schooling, primary school incomplete or complete, secondary school incomplete or complete, and education beyond secondary school (higher education). Income was classified by <$1 United States dollars (USD)/dependent/day, $1–2 USD/dependent/day and >$2 USD/dependent/day. Personal health habits that we collected included a history of ever smoking tobacco, drinking alcohol, smoking marijuana, using cocaine/crack or drinking coffee. For residency history, participants in five of six communities (1,088 people) were asked of previous or current urban or rural residency. Family history asked participants to report their relatives' medical conditions. Analyses were performed using SPSS version 19.0 for Windows.

RESULTS

Participation rates ranged from 76.9% to 86.2% of all adults between ages 20–60 years in the selected communities. The study sample included 1,355 adults. It is unknown if there was any substantial difference between study participants and eligible adults who chose not to participate. The demographic characteristics of the study population are shown in Table 1. Of the cardiovascular risk factors screened (hypertension, diabetes, smoking, obesity), 50.1% of participants had at least one and 13.4% had at least two risk factors.

The prevalence of hypertension was 22.0%, 19.2% in men and 24.2% in women. Among hypertensives (n=298), 24.2% (72) were normotensive, 21.5% (64) were prehypertensive, 39.6% (118) had stage I hypertension and 14.8% (44) had stage II hypertension. The prevalence of diabetes was 3.0%, 1.2% of men and 4.3% of women. Additional characteristics of hypertensives (included controlled individuals) are shown in Table 2. Risk factors correlating with hypertension and diabetes in this population are shown in Table 3.

Figure 1 demonstrates adjusted risks for hypertension and uncontrolled

Table 3. Risk factors for hypertension and diabetes

	HTN OR (95% CI)		DM OR (95% CI)	
Independent Variable	**Bivariate**	**Adjusted**	**Bivariate**	**Adjusted**
Sex (women = ref)	.75 (.57–.97)	1.12 (.81–1.56)	.27 (.12–.61)	.31 (.11–.86)
Age, years				
20–29 (ref)	1	1	1	1
30–39	1.75 (1.23–2.51)	1.30 (.85–2.00)	2.90 (.72–11.65)	2.80 (.51–15.4)
40–49	3.34 (2.33–4.79)	2.50 (1.59–3.91)	12.0 (3.49–41.32)	12.0 (2.30–62.2)
50–60	4.85 (3.24–7.27)	3.96 (2.35–6.66)	17.14 (4.86–60.5)	18.9 (3.43–103)
BMI				
<25.0 (ref)	1	1	1	1
Overweight	1.64 (1.20–2.24)	1.58 (1.07–2.33)	2.79 (1.24–6.27)	1.92 (.67–5.48)
Obese	3.06 (2.21–4.23)	2.70 (1.80–4.06)	3.04 (1.29–7.20)	1.12 (.36–3.49)
Years of education				
None (ref)	1	1	1	1
Primary incomplete	.59 (.42–.83)	.80 (.52–1.23)	.51 (.24–1.08)	.75 (.27–2.12)
Primary complete	.47 (.31–.72)	.67 (.40–1.11)	.39 (.14–1.11)	1.39 (.39–4.96)
Secondary incomplete	.40 (.26–.63)	.76 (.43–1.33)	.36 (.12–1.10)	1.70 (.40–7.22)
Secondary complete	.54 (.27–1.07)	1.09 (.49–2.39)	.31 (.04–2.43)	1.14 (.11–12.0)
Higher education	.32 (.15–.70)	.51 (.21–1.27)	.62 (.14–2.78)	1.87 (.27–12.7)
Residency – urban				
Never (ref)	1	1	1	1
Sometimes	.63 (.43–.93)	.52 (.34–.79)	.71 (.27–1.90)	.47 (.16–1.42)
Always	.94 (.60–1.50)	.90 (.53–1.50)	.83 (.25–2.82)	.58 (.14–2.37)
Family history[a]				
HTN	1.47 (1.13–1.90)	1.60 (1.16–2.20)	1.87 (.99–3.56)	1.26 (.55–2.89)
DM	1.58 (1.14–2.19)	1.32 (.88–1.99)	4.51 (2.38–8.56)	5.50 (2.39–12.6)
CKD	1.33 (.92–1.91)	–	2.08 (.97–4.45)	–
Smoking - ever[a]	1.08 (.82–1.42)	–	.83 (.41–1.67)	–
Alcohol - ever[a]	1.18 (.91–1.53)	–	.65 (.34–1.24)	–
Drugs - ever[a]	.74 (.39–1.39)	–	–	–
Coffee drinker[a]	1.52 (1.15–2.00)	1.22 (.89–1.69)	2.44 (1.11–5.33)	1.36 (.56–3.28)

All adjusted OR's controlled for sex, age, BMI, DM prevalence (for HTN analyses), HTN prevalence (for DM analyses), schooling, coffee drinking, urban living history and family history of HTN or DM.

[a] No/None as referent. Elsewhere in table referents are directly identified.

Ref, referent; OR, odds ratio; HTN, hypertension; DM, diabetes; BMI, body mass index; CKD, chronic kidney disease.

hypertension stratified by sex. Increasing age proved a greater risk factor among women (40–49 years old odds ratio [OR] = 3.60; 95% confidence interval [CI] 1.90–6.80; 50–60 years old OR 7.04; 95% CI 3.44–14.4) while obesity was a greater risk factor among men (OR 3.37; 95% CI 1.71–6.65). A negative association between hypertension and history of both urban and rural living was observed in women (OR 0.47; 95% CI 0.26–0.86). Completing primary school was independently associated with decreased prevalence of hypertension (OR 0.40; 95% CI 0.19–0.85) and uncontrolled hypertension (OR 0.29; 95% CI 0.10–0.88) in women.

Blood pressure was controlled in 55.1% of female hypertensives and 31.0% of male hypertensives (OR 2.86; 95% CI 1.74–4.69) (Table 4). There were no significant associations between baseline covariates and control of hypertension.

The logistic regression models that controlled for urban/rural living history included only the 1,088 participants for whom this data was available. Full analyses that included the sixth community's residents were also performed. These residents were input into the model as variables coded as never urban. These analyses demonstrated no substantial change in results presented in Table 3.

DISCUSSION

In this cross-sectional survey of 1,355 Nicaraguans, half had at least one documented cardiovascular risk factor. Hypertension and diabetes were more prevalent among women though more poorly controlled in men. The lowest prevalence of hypertension among women was found among those completing only primary education (as compared to no education), a novel finding.

It is important to examine our results within the larger context of Latin American and the United States. When compared to the prevalence of hypertension reported by the CARMELA

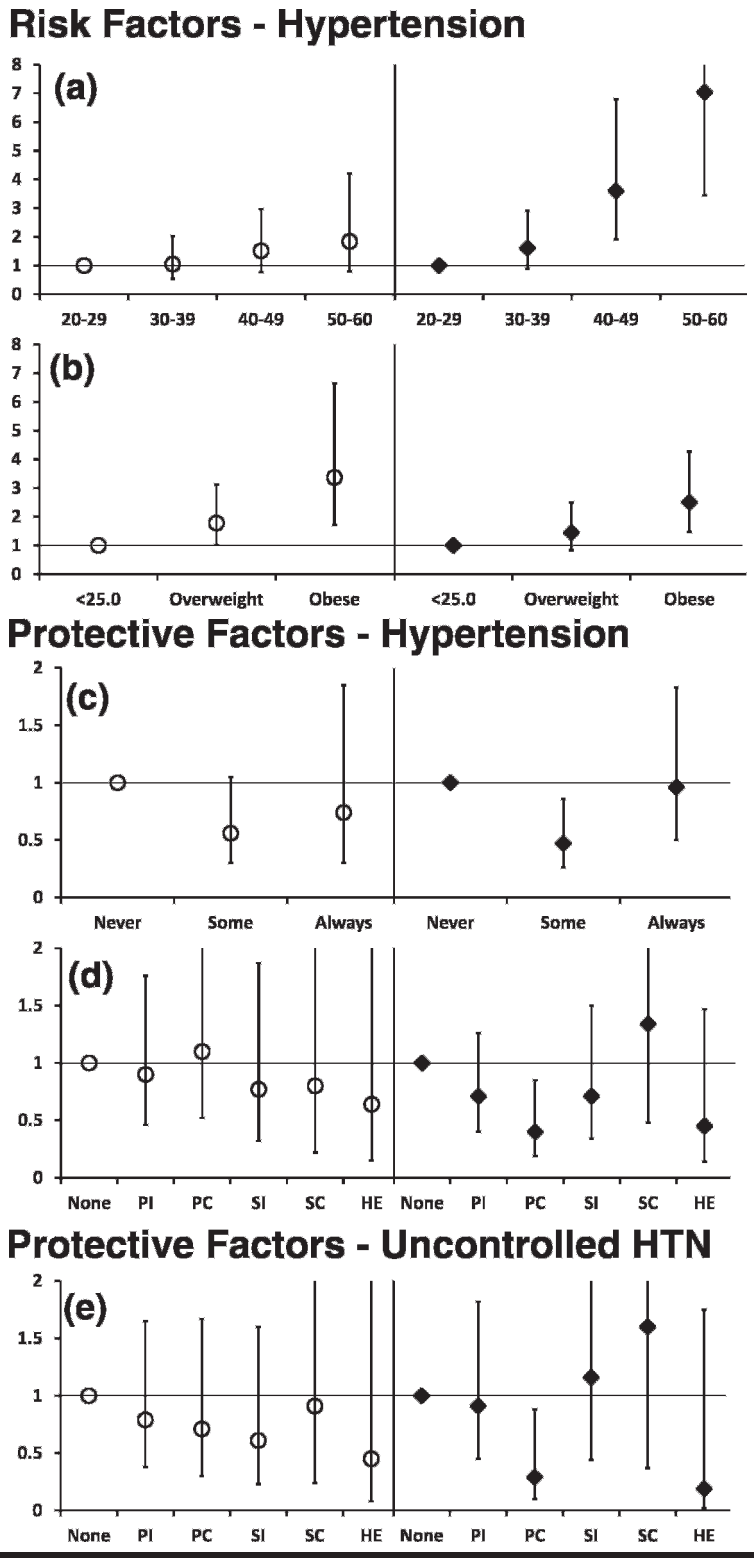

Fig 1. Associated risk factors for hypertension among men (circles on left) and women (diamonds on right) including (a) age group (in years), (b) body mass index (in kg/m^2), (c) never, sometimes, or always living in an urban setting, (d) educational level including no education (None), primary incomplete (PI), primary complete (PC), secondary incomplete (SI), secondary complete (SC) and higher education (HE), and associated risk factors for uncontrolled hypertension in each sex by (e) educational level

The lowest prevalence of hypertension among women was found among those completing only primary education (as compared to no education), a novel finding.

studies among urban Latin Americans aged 25–64 years (with similar blood pressure measuring techniques), this study had a slightly higher hypertension prevalence (18% vs 22%) and a slightly lower diabetes prevalence (7% vs 3%). Acosta-Cázares nationwide sample in Mexico also reported prevalence of hypertension at 29% and diabetes at 13% in a sample that included people aged ≥20 years. Compared to a previous study, in a different region of Nicaragua, that recruited eye clinic patients,[15] our hypertension prevalence was noticeably lower (41% vs 22%). The prevalence of hypertension found in our study is lower than the most recent US NHANES hypertension prevalence among those aged ≥18 years (22.0% vs 29.0%)[32] and lower than the NHANES diabetes prevalence among those aged 30–59 (8.4% vs 3%).[33] Among all hypertensives, including individuals receiving treatment, our study's mean blood pressure (134.0/81.0) closely approximates the mean NHANES blood pressure among all hypertensives (135.2/74.1).[32] These results demonstrate similar prevalences of hypertension in a poorer, more rural Nicaraguan study population as compared to urban settings in wealthier Latin American countries and the United States.

Among women of different educational levels (compared to no schooling), only those completing primary school demonstrated a significant decrease in prevalence of both hypertension and uncontrolled hypertension.

Table 4. Hypertension control among study participants

Variable	Controlled HTN, *n* (%)	Uncontrolled HTN, *n* (%)
Overall	136 (45.6)	162 (54.4)
Sex		
Men	35 (31.0)	78 (69.0)
Women	102 (55.1)	83 (44.9)
Age, years		
20–29	33 (48.5)	35 (51.5)
30–39	40 (52.6)	36 (47.4)
40–49	40 (45.5)	48 (54.5)
50–60	24 (36.4)	42 (63.6)
Attended school		
Yes	95 (44.8)	117 (55.2)
No	42 (48.8)	44 (51.2)
Education level		
No formal education	42 (48.8)	44 (51.2)
Primary incomplete	46 (40.7)	67 (59.3)
Primary complete	24 (55.8)	19 (44.2)
Secondary incomplete	14 (42.4)	19 (57.6)
Secondary complete	5 (41.7)	7 (58.3)
Higher education	5 (62.5)	3 (37.5)
Poverty level, USD		
<$1/day	33 (36.7)	57 (63.3)
$1–2/day	27 (40.9)	39 (59.1)
>$2/day	15 (50.0)	15 (50.0)
Residency – urban		
Never	67 (69.8)	106 (74.6)
Sometimes	13 (13.5)	25 (17.6)
Always	16 (16.7)	11 (7.7)

HTN, Hypertension; USD, United States Dollars.

Previous research has demonstrated lower incidence of noncommunicable diseases among those with higher education[20,21] but not primary education. Higher education levels did trend towards correlating with lower prevalence of hypertension among women in this study but few people (4.5%) had attained higher education. This result is surprising due to the general link between higher education, wealth and better health previously demonstrated elsewhere in Latin America.[20,21,25] Our findings support the position that completing primary education plays a protective role in the health of Nicaraguan women.

A previous history of living in both urban and rural settings was associated with lower prevalence of hypertension among all study participants and uncontrolled hypertension among female participants. This mobile cohort was no wealthier than the exclusively rural or urban cohorts. We hypothesize that the non-mobile urban and rural prevalences of hypertension were similar because many of the risk factors for cardiovascular disease commonly found in urban areas are already present in rural Nicaragua, notably a diet high in fried foods.

The strengths of this study included high participation rates among populations drawn from three different departments with six different economies in rural and urban settings. Weaknesses included higher participation rates at all sites among women. However, in each village, among men eligible to take part in the study, participation rates were never lower than 66.7%. Additionally, screening for diabetes using fasting blood glucose levels was not logistically feasible in our sample. Post-prandial glucosuria has been shown to have a 43% sensitivity, 98% specificity, and 53% positive predictive value and is considered an acceptable screening tool.[34] Coupled with prior diagnosis of diabetes by a medical professional, our approach represents a specific but less sensitive diagnostic algorithm.

Our study found Nicaragua has prevalence of hypertension similar to many previously studied regions of Latin America and the United States. Further studies in Nicaragua would do well to further address differences in rural and urban cardiovascular disease risk and characterize epidemiologic patterns in the nation's other regions, especially as the only other study of hypertension prevalence in Nicaragua reported dissimilar results.[15]

In addition to traditional targets like infectious diseases and maternal-fetal health, rural populations should be educated about health behaviors that would attenuate the dangers of noncommunicable diseases like diabetes and hypertension. In addition, the low rates of hypertension control among men argues for increased/changed rural health clinic hours when men could more readily access the blood pressure and diabetes medications already available. In rural Nicaragua, women access health care much more frequently than men partially because of limited clinic hours generally confined to the times when men work.

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REFERENCES

1. Tejero ME. Cardiovascular disease in Latin American women. *Nutr Metab Cardiovasc Dis.* 2010;20(6):405–411.

2. Murray CJL, Lopez AD, eds. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020*. Boston, Mass: Harvard School of Public Health; 1996.
3. Silva H, Hernandez-Hernadez R, Vinueza R, et al. Cardiovascular risk awareness, treatment, and control in urban Latin America. *Am J Ther*. 2010;17(2):159–166.
4. Schargrodsky H, Hernandez-Hernandez R, Champagne BM, et al. CARMELA: assessment of cardiovascular risk in seven Latin American cities. *Am J Med*. 2008;121(1):58–65.
5. Hernandez-Hernandez R, Silva H, Velasco M, et al. Hypertension in seven Latin American cities: the Cardiovascular Risk Factor Multiple Evaluation in Latin American (CARMELA) study. *J Hypertens*. 2010;28(1):24–34.
6. Escobedo J, Buitron LV, Velasco MF, et al. High prevalence of diabetes and impaired fasting glucose in urban Latin America: the CARMELA study. *Diabet Med*. 2009;26(9):864–871.
7. Escobedo J, Schargrodsky H, Champagne B, et al. Prevalence of the metabolic syndrome in Latin America and its association with subclinical carotid atherosclerosis: the CARMELA cross sectional study. *Cardiovasc Diabetol*. 2009;26;8:52.
8. Vinueza R, Boissonnet CP, Acevedo M, et al. Dyslipidemia in seven Latin American cities: CARMELA study. *Prev Med*. 2010;50(3): 106–111.
9. Acota-Cázares B, Escobedo-de la Peña J. High burden of cardiovascular disease risk factors in Mexico: An epidemic of ischemic heart disease that may be on its way? *Am Heart J*. 2010; 160(2):230–6.
10. Bermudez V, Marcano RP, Cano C, et al. The Maracaibo city metabolic syndrome prevalence study: design and scope. *Am J Ther*. 2010; 17(3):288–294.
11. Smith KV, Goldman N. Socioeconomic differences in health among older adults in Mexico. *Soc Sci Med*. 2007;65(7):1372–1385.
12. Groeneveld IF, Solomons NW, Doak CM. Nutritional status of urban schoolchildren of high and low socioeconomic status in Quetzaltenango, Guatemala. *Rev Panam Salud Publica*. 2007;22(3):169–177.
13. The World Bank: Data - Country and Lending Groups. Available at: http://data.worldbank.org/about/country-classifications/country-and-lending-groups#Low_income. Accessed March 19, 2011.
14. Mendez-Chacon E, Santamaria-Ulloa C, Rosero-Bixby L. Factors associated with hypertension prevalence, unawareness and treatment among Costa Rican elderly. *BMC Public Health*. 2008;8:275–285.
15. Blondin NA, Lewis J. Prevalence, awareness, treatment and control of hypertension in a rural Nicaraguan sample. *J Hum Hypertension*. 2007;21(10):815–817.
16. Mittal BV, Singh AK. Hypertension in the developing world: challenges and opportunities. *Am J Kidney Dis*. 2010;55(3):590–598.
17. Goldhaber-Fiebert JD, Goldhaber-Fiebert SN, Andorsky DJ. Male involvement in cardiovascular preventive healthcare in two rural Costa Rican communities. *Prev Med*. 2005;40(6): 690–695.
18. Champagne BM, Sebrie EM, Schargrodsky H, Pramparo P, Boissonnet C, Wilson E. Tobacco smoking in seven Latin American cities: the CARMELA study. *Tob Control*. 2010;19(6): 457–462.
19. Kabagambe EK, Baylin A, Campos H. Nonfatal acute myocardial infarction in Costa Rica: modifiable risk factors, population-attributable risks, and adherence to dietary guidelines. *Circulation*. 2007;6:115(9): 1075–1081.
20. Fleischer NL, Diez Roux AV, Alazraqui M, Spinelli H. Social patterning of chronic disease risk factors in a Latin American city. *J Urban Health*. 2008;85(6):923–937.
21. Koch E, Romero T, Romero CX, et al. Impact of education, income and chronic disease risk factors on mortality of adults: does 'a pauper-rich paradox' exist in Latin American societies? *Public Health*. 2010;124(1):39–48.
22. Ala L, Gill G, Gurgel R, Cuevas L. Evidence for affluence-related hypertension in urban Brazil. *J Hum Hypertens*. 2004;18(11): 775–779.
23. Glassman A, Gaziano TA, Bouillon Buendia CP, Guanais de Aguiar FC. Confronting the chronic disease burden in Latin American and the Caribbean. *Health Aff (Millwood)*. 2010;29 (12):2142–8.
24. Rubinstein A, Alcocer L, Chagas A. High blood pressure in Latin America: a call to action. *Ther Adv Cardiovasc Dis*. 2009;3(4): 259–285, Review.
25. Colon-Ramos U, Kabagambe EK, Baylin A, Ascherio A, Campos H, Peterson KE. Socioeconomic status and health awareness are associated with choice of cooking oil in Costa Rica. *Public Health Nutr*. 2007;10(11):1214–1222.
26. Thow AM, Hawkes C. The implications of trade liberalization for diet and health: a case study from Central America. *Global Health*. 2009;5:5.
27. Organización Panamericana de la Salud. Oficina Regional de la Organización Mundial de la Salud. *CARMEN: Una iniciativa para Conjunto de Acciones para la Reducción Multifactorial de Enfermedades No transmisibles*. 2003 October;3–4, Available at http://www.paho.org/spanish/ad/dpc/nc/CARMEN-doc2.pdf. Accessed January 6, 2012.
28. Collier G, Greenan MC, Brady JJ, Murray B, Cunningham SK. A study of the relationship between albuminuria, proteinuria, and urinary reagent strips. *Ann Clin Biochem*. 2009;46 (Pt. 3):247–249.
29. Korpi-Steiner NL, Williamson EE, Karon BS. Comparison of three whole blood creatinine methods for estimation of glomerular filtration rate before radiographic contrast administration. *Am J Clin Pathol*. 2009;132(6):920–926.
30. Levey AS, Coresh J, Greene T, et al. Using standardized serum creatinine values in the modification of diet in renal disease study equation for estimating glomerular filtration rate. *Ann Intern Med*. 2006;145(4):247–254.
31. Levey AS, Coresh J, Balk E, et al. National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Ann Intern Med*. 2003; 139(2):137–147.
32. Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988–2008. *JAMA*. 2010; 303(20):2043–2050.
33. Danaei G, Friedman AB, Oza S, Murray CJ, Ezzati M. Diabetes prevalence and diagnosis in US states: analysis of health surveys. *Popul Health Metr*. 2009;7:16.
34. Davies MJ, Williams DR, Metcalfe J, Day JL. Community screening for non-insulin-dependent diabetes mellitus: self-testing for post-prandial glycosuria. *Q J Med*. 1993;86(10): 677–684.

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