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Factors Associated with Hypertension Awareness, Treatment, and Control

Factores asociados con el conocimiento del diagnóstico, tratamiento y control de la Hipertensión Arterial

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Abstract

Introduction: Hypertension (HTN) is one of the leading causes of global mortality, and its diagnosis, treatment, and control remain major challenges in low- and middle-income countries. **Objective:** To estimate the prevalence of HTN awareness, treatment, and control and identify associated factors in an urban cohort. **Methodology:** An analytical cross-sectional study nested within a population-based cohort from socioeconomic strata 2 and 3 was conducted. A total of 543 individuals with HTN, including those identified at baseline and incident cases detected during follow-up visits, were included. Prevalence estimates were calculated, and logistic regression models were fitted, including a proxy variable ("follow-up") to capture unmeasured changes. The outcomes were: (1) awareness of diagnosis, (2) pharmacological treatment, and (3) control of HTN. **Results:** The mean age was 52.09 years (SD: 10.6), and 65.56% were women. The prevalence of awareness of diagnosis, treatment, control, and control among treated individuals was 61.68%, 51.01%, 32.04%, and 60.16%, respectively. In the multivariate model, male sex was associated with a lower probability of HTN awareness (OR 0.61; 95% CI 0.40–0.93), whereas the probability increased with factors such as being married (OR 1.88; 95% CI 1.10–3.22), having abdominal obesity (OR 1.94; 95% CI 1.21–3.11), and having health insurance (OR 1.65; 95% CI 1.10–2.48). Health insurance coverage increased the probability of receiving treatment, whereas in men, it was lower. Dyslipidemia reduced the probability of HTN control. Participation in follow-up assessments was associated with a higher probability of receiving treatment and achieving control compared with individuals assessed at baseline only. **Conclusion:** The low prevalence of awareness of diagnosis, treatment, and control of HTN highlights the need for targeted interventions. Sex- and clinical factor-related gaps persist. Strengthening health insurance coverage and targeted health education for men could improve HTN control and reduce the cardiovascular burden.

Keywords: Hypertension; Awareness; Treatment; Control; Dyslipidemia; Health Insurance.

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Resumen

Introducción: La hipertensión arterial (HTA) es una de las principales causas de mortalidad mundial y su diagnóstico, tratamiento y control son problemáticos en países de ingresos bajos y medianos. **Objetivo:** Estimar la prevalencia del conocimiento del diagnóstico, tratamiento y control de la HTA, y determinar sus factores asociados en una cohorte urbana. **Metodología:** Estudio analítico de corte transversal, anidado en una cohorte poblacional de estratos socioeconómicos 2 y 3. Se incluyeron 543 personas hipertensas identificadas en la línea basal y casos incidentes en los seguimientos. Se estimaron prevalencias y se ajustaron modelos de regresión logística incorporando una variable proxy ("seguimiento") para capturar cambios no medidos. Los desenlaces fueron: (1) conocimiento del diagnóstico, (2) tratamiento farmacológico y (3) control de la HTA. **Resultados:** La edad media fue 52,09 años (DE: 10,6) y el 65,56% fueron mujeres. La prevalencia de conocimiento del diagnóstico, tratamiento, control y control entre tratados fue 61,68%, 51,01%, 32,04% y 60,16%, respectivamente. En el modelo multivariado, el sexo masculino se asoció con menor probabilidad de conocimiento del diagnóstico (OR 0,61; IC95% 0,40–0,93), mientras que la probabilidad aumentó con factores como estar casado (OR 1,88; IC95% 1,10–3,22), tener obesidad abdominal (OR 1,94; IC95% 1,21–3,11) y tener aseguramiento en salud (OR 1,65; IC95% 1,10–2,48). El aseguramiento aumentó la probabilidad de tratamiento, mientras que en hombres esta fue menor. La dislipidemia disminuyó la probabilidad de control. La participación en los seguimientos se asoció con mayor probabilidad de tratamiento y control frente a quienes solo estuvieron en la línea basal. **Conclusión:** La baja prevalencia del conocimiento del diagnóstico, tratamiento y control de la HTA resalta la necesidad de intervenciones focalizadas. Persisten brechas por sexo y factores clínicos. Fortalecer el aseguramiento y la educación sanitaria dirigida a hombres podría mejorar el control de la HTA y reducir la carga cardiovascular.

Palabras clave: Hipertensión Arterial; Conocimiento; Tratamiento; Control; Dislipidemias; Aseguramiento en Salud.

Introduction

Hypertension (HTN) affects approximately one in three adults worldwide[1] and is a major risk factor for cardiovascular events, such as stroke, myocardial infarction, heart failure, kidney disease, and other complications. There are substantial differences in the prevalence of HTN between high-income countries and low- and middle-income countries (LMICs)[2], with evidence indicating that in 2019, 82% of all people with HTN (more than one billion individuals) were living in LMICs[3]. In these settings, the high prevalence is associated with low awareness of diagnosis and deficiencies in treatment and control of the disease[2]. Despite multiple initiatives implemented to improve HTN care, its burden continues to be evident in morbidity and mortality caused by cardiovascular diseases (CVDs)[2,3].

Recent studies show that socioeconomic, cultural, and clinical determinants significantly influence HTN awareness, treatment, and control. In LMICs, inequity, poverty, and illiteracy are the main barriers to the adoption and adaptation of health programs designed in high-income settings[4,5]. In this regard, updates to international evidence-based clinical guidelines highlight the need to tailor HTN prevention and control strategies to the characteristics of each population, as reflected in guidelines from the United States[6], Europe[7], the United Kingdom[8], Canada[9], and Japan[10], among others.

Likewise, the 2020 clinical practice guidelines of the International Society of Hypertension (ISH) propose a "harmonization" strategy, emphasizing that the lack of trained personnel to establish a diagnosis, the absence of utility services in rural hospitals, limited access to basic equipment for HTN detection, and barriers to obtaining affordable, high-quality treatment should not preclude timely diagnosis or optimal HTN management and control in resource-constrained settings[11]. However, material limitations alone do not fully explain the outcomes; it is also considered that the success of implementing guidelines and strategies to reduce the prevalence of uncontrolled HTN largely depends on identifying and quantifying factors associated with awareness of diagnosis (or having been diagnosed), as well as treatment and control of HTN within each population[12]. This study aims to determine these factors in an urban, population-based cohort to provide evidence to inform the design of more effective public health interventions.

Methodology

An analytical cross-sectional study nested within a population-based cohort was conducted. The cohort included a random sample of 2,432 individuals aged 15 to 64 years residing in 40 neighborhoods of lower-middle socioeconomic strata (levels 2 and 3), who underwent a baseline assessment between 2001 and 2002. The first follow-up was conducted in 2007, during which 1,642 participants were contacted. The second follow-up was conducted in two phases: the first in 2013, during which 481 individuals were assessed; and the second between 2016 and 2017, during which an additional 670 participants were evaluated, resulting in a total of 1,151 participants in the second follow-up.

For this study, prevalent HTN cases identified at baseline and incident cases identified during the first and second follow-ups were considered. This subpopulation was used to evaluate factors associated with awareness of HTN diagnosis. Subsequently, the analysis was restricted to participants who were aware of their condition to assess the factors associated with receiving pharmacological treatment for it. Finally, among those receiving treatment, the factors associated with disease control were evaluated. Pregnant women at the time of cohort assessments and individuals unable to respond to an interview or to stand upright were excluded.

The outcome variables analyzed in this study were:

1) Awareness of the HTN diagnosis (prior knowledge of being hypertensive): a person was considered to be aware of their condition if they reported having a medical diagnosis of HTN and, additionally, met at least one of the following criteria: (i) self-report and documented use of antihypertensive medication, or (ii) an average of two blood pressure (BP) measurements obtained using an automatic arm monitor (OMRON HEM-705 CP) showing systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg (or SBP ≥130 mmHg or DBP ≥80 mmHg for individuals with diabetes or CKD).
1) Pharmacological treatment of HTN (Treatment): This was defined based on self-report and documentation of antihypertensive medications prescribed by a treating physician.
1) HTN control (Control): An individual was considered to have controlled HTN when the average of two measurements showed SBP <140 mmHg and DBP <90 mmHg. Among individuals with diabetes or CKD, control was defined as an average SBP <130 mmHg and DBP <80 mmHg.

The sample size was determined based on the methodological criteria of the INEFAC cohort, assuming a 95% confidence level ($\alpha = 0.05$) and 80% statistical power ($\beta = 0.20$), with a 1:2 ratio of exposed to unexposed individuals. This calculation was performed using Stata version 14 (StataCorp, College Station, TX, USA), assessing different scenarios for the main exposure variables reported in the literature and in the original cohort. Based on these parameters, a final sample size of 543 participants ensured the detection of associations of moderate magnitude with adequate statistical precision.

In the statistical analysis, proportions with confidence intervals were calculated for categorical variables, and measures of central tendency and dispersion were calculated for continuous variables according to their distributions. Normality was assessed using the Shapiro–Wilk test. In bivariate analyses of outcomes and categorical independent variables, Pearson's chi-square (χ^2) test or Fisher's exact test was used. Continuous variables with a normal distribution were analyzed using Student's t-test, whereas variables with a non-normal distribution were analyzed using the nonparametric Mann–Whitney U test. Subsequently, logistic regression models were fitted, including a proxy variable, also referred to as an instrumental variable, termed "follow-up," to capture unmeasured temporal changes (e.g., environmental variables, diagnostic capacity, access to health services, among others). Model goodness of fit was evaluated using the Hosmer–Lemeshow test and Pearson's χ^2 statistic; discriminatory capacity was assessed through the area under the receiver operating characteristic (ROC) curve. The impact of cohort loss to follow-up was also analyzed.

Before the final estimation, potential spurious relationships among the independent variables were assessed. Collinearity was assessed using the variance inflation factor (VIF), with no evidence of values that would compromise model stability (VIF < 10 in all variables). Likewise, theoretically plausible interactions were

explored, with no significant effect modification identified. These checks ensured the internal consistency of the multivariable model and the validity of the estimates.

Results

All individuals with HTN identified at baseline, as well as incident cases identified during the first and second follow-up assessments, were included. A total of 543 participants with HTN were included in the analysis. The mean age was 52.09 ± 10.61 years, and the proportion of women was 65.56% (356 participants). Regarding marital status, 38.75% of participants were married, most of whom were women. Since the baseline cohort was established in socioeconomic strata 2 and 3, most individuals continued in these strata in similar proportions; however, 6% migrated to other socioeconomic strata, mainly stratum 1. Concerning self-rated health, 44.46% of participants perceived their health as fair, especially women. The mean body mass index (BMI) was 28.18 kg/m^2, higher among women. When categorized, 43.15% of participants were overweight, more frequently men, and 32.41% had obesity, more frequently women. A total of 13.13% reported current smoking, with a higher proportion among men **(Table 1).**

Table 1. Population description by sex.

Variable	Total n= 543	Women n=356	Men n=187	p-value
	Median or proportion (95% CI)			
Age(years)	52.09(51.2 – 52.9)	53.06 (51.9 – 54.1)	50.26 (48.7–51.7)	**0.003**
Weight (Kg)	69.9 (68.7 – 71.1)	67.02 (65.7 – 68.3)	75.55 (73.4–77.6)	**<0.001**
Height (m)	1.57(1.56-1.58)	1.52(1.52 – 1.53)	1.66 (1.65–1.67)	**<0.001**
BMI	28.18(27.7 – 28.5)	28.69(28.1 – 29.2)	27.20 (26.5–27.8)	**<0.001**
Waist circumference	87.86(86.8 – 88.8)	85.66(84.4 – 86.8)	92.04 (90.2–93.7)	**<0.001**
Hip circumference	99.65(98.7 – 100.5)	101.12(99.9 – 102.3)	96.84 (95.5–98.1)	**<0.001**
Waist-hip ratio	0.88(0.87 – 0.89)	0.84(0.84 – 0.85)	0.94 (0.93–0.95)	**<0.001**
Total cholesterol	219.88(216.1 – 223.6)	226.34(221.7 – 230.9)	207.66 (201.4–213.8)	**<0.001**
HDL	42.32(41.4 – 43.2)	44.03(42.9 – 45.1)	39.07 (37.5–40.5)	**<0.001**
LDL	138.82(135.6 – 142.0)	146.35(142.5 – 150.2)	124.52 (119.3–129.7)	**<0.001**
Triglycerides	166(125 – 234)	157.5(122.17 – 213)	197.5 (130–285.8)	**<0.001***
Mets[£]	0(0 – 445.5)	0(0- 360)	29.7 (0–462)	0.363*
Marital status				<0.001
Single	19.0(15.9 – 22.5)	19.66(15.8 – 24.1)	17.74 (12.8–23.9)	
Married	38.75(34.7 – 42.9)	32.58(27.8 – 37.6)	50.54 (43.3–57.7)	
Widowed	12.18(9.6 – 15.2)	17.42(13.8 – 21.7)	2.15 (0.8–5.6)	
Cohabiting	19.74(16.5 – 23.3)	18.26(14.5 – 22.6)	22.58 (17.1–29.1)	
Separated	10.33(8.0 – 13.2)	12.08(9.1 – 15.9)	6.99 (4.1–11.7)	
Socioeconomic stratum				0.624
Informal settlement	0.18(0.02 – 1.3)	0.28(0.03 – 1.9)	-	
1	4.62(3.1 – 6.7)	4.76(2.9 – 7.5)	4.30(2.1 – 8.3)	
2	48.43(44.2-52.6)	50.42(45.2 – 55.6)	44.62(37.5 – 51.8)	
3	45.47(41.3 – 49.6)	43.38(38.2 – 48.6)	49.46(42.2 – 56.6)	
4	1.29(0.6 – 2.6)	1.13(0.4 – 2.9)	1.61(0.5 – 4.9)	
Skin color				0.316
White	40.15(36.1 – 44.3)	42.42(37.3 – 47.6)	35.83(29.2 – 42.9)	
Mestizo	57.46 (53.2–61.5)	55.62 (50.3–60.7)	60.96 (53.7 – 67.7)	
Mulatto	1.10 (0.4–2.4)	1.12 (0.4–2.9)	1.07 (0.2 – 4.2)	
Black	1.29 (0.6–2.6)	0.84 (0.2–2.5)	2.14 (0.7 – 5.5)	
Education level				0.006
None	14.53 (11.7–17.7)	17.23 (13.6–21.5)	9.29 (5.8 – 14.4)	
Primary	49.16 (44.9–53.3)	50.28 (45.1–55.4)	46.99 (39.8 – 54.2)	

Variable	Total n= 543	Women n=356	Men n=187	p-value
	Median or proportion (95% CI)			
Secondary	29.05 (25.3–33.0)	27.12 (22.7–32.0)	32.79 (26.3 – 39.9)	
Technical	3.54 (2.2–5.4)	1.98 (0.9–4.1)	6.56 (3.7 – 11.2)	
University	3.72 (2.4–5.7)	3.39 (1.9–5.8)	4.37 (2.1 – 8.5)	
Occupation				<0.001
Professional, technical, administrative	10.33 (8.03–13.19)	6.46 (4.32–9.54)	17.74 (12.86 – 23.95)	
Commerce and own business	23.62 (20.22–27.38)	14.61 (11.29–18.68)	40.86 (33.98 – 48.11)	
General labor	13.10 (10.50–16.21)	12.08 (9.07–15.90)	15.05 (10.57 – 20.98)	
Homemaker and unpaid work	35.06 (31.14–39.17)	52.53 (47.31–57.68)	1.61 (0.51 – 4.91)	
Other	5.54 (3.89–7.81)	3.93 (2.33–6.54)	8.60 (5.31 – 13.61)	
Students, retirees, individuals with disabilities	12.36 (9.84–15.41)	10.39 (7.61–14.03)	16.13 (11.48 – 22.17)	
Paid employment				<0.001
No	49.53 (45.30–53.76)	62.71 (57.53–67.61)	24.04 (18.36 – 30.81)	
Yes	50.47 (46.23–54.69)	37.29 (32.38–42.46)	75.96 (69.18 – 81.63)	
Housing				0.719
Owned	66.05 (61.94–69.92)	64.04 (58.90–68.88)	68.89 (62.87 – 76.08)	
Rented	30.07 (26.35–34.07)	31.74 (27.09–36.77)	26.88 (20.96 – 33.75)	
Tenement	2.58 (1.53–4.31)	2.81 (1.51–5.15)	2.15 (0.80 – 5.62)	
Informal settlement	0.18 (0.02–1.30)	0.28 (0.03–1.97)	--	
Loaned housing	1.11 (0.49–2.44)	1.96 (0.42–2.96)	0.61 (0.26 – 4.23)	
Self-rated health				<0.001
Excellent	8.12 (6.09–10.74)	5.90 (3.87–8.88)	12.37 (8.33 – 17.96)	
Good	40.96 (36.88–45.16)	36.52 (31.65–41.66)	49.46 (42.29 – 56.65)	
Fair	44.46 (40.32–48.68)	50.48 (45.64–56.02)	32.26 (25.89 – 39.35)	
Poor	6.46 (4.66–8.86)	6.74 (4.55–9.87)	5.91 (3.29 – 10.39)	
BMI				<0.001
Underweight	1.67 (0.86–3.17)	1.98 (0.94–4.09)	1.08 (0.26 – 4.23)	
Normal	22.78 (19.42–26.51)	20.34 (16.45–24.87)	27.42 (21.45 – 34.31)	
Overweight	43.15 (39.01–47.37)	38.42 (33.47–43.61)	52.15 (44.92 – 59.28)	
Obesity	32.41 (28.58–36.48)	39.27 (34.29–44.46)	19.35 (14.26 – 25.71)	
Smoking status				<0.001
Never smoker	48.62 (43.92–53.33)	59.93 (53.96–65.61)	29.63 (23.06 – 37.16)	
Former smoker	38.25 (33.77–42.92)	30.88 (25.65–36.65)	37.00 (42.90 – 58.29)	
Current smoker	13.13 (10.26–16.66)	9.19 (6.27–13.26)	19.75 (14.28 – 26.65)	
Health insurance				0.796
Uninsured	39.85 (35.80–44.04)	40.73 (35.72–45.93)	38.17 (31.43 – 45.40)	
Insured	53.32 (49.09–57.49)	52.81 (47.59–57.96)	54.30 (47.05 – 61.36)	
Yes, but not always	6.83 (4.98–9.28)	6.46 (4.32–9.54)	7.53 (4.49 – 12.34)	
Insurer				0.242
ARS	27.01 (22.98–31.46)	27.60 (22.65–33.16)	25.87 (19.31 – 33.73)	
EPS	42.89 (38.23–47.67)	40.14 (34.52–46.03)	48.25 (40.11 – 56.48)	
Other	30.09 (25.89–34.65)	32.26 (27.01–37.99)	25.87 (19.31 – 33.73)	
Parental MI				0.257
Both	3.51 (2.24–5.43)	4.21 (2.55–6.88)	2.15 (0.81 – 5.62)	
Mother only	11.99 (9.51–15.01)	13.48 (10.30–17.45)	9.14 (5.73 – 14.24)	
Father only	13.10 (10.50–16.21)	13.76 (10.54–17.76)	11.83 (7.89 – 17.35)	
Neither	51.66 (47.44–55.85)	48.88 (43.69–54.08)	56.99 (49.73 – 63.95)	
Unknown	19.74 (16.49–23.31)	19.66 (15.84–24.13)	19.89 (14.73 – 26.29)	

Variable	Total n= 543	Women n=356	Men n=187	p-value
	Median or proportion (95% CI)			
Sibling MI				0.596
No	85.26 (81.73–88.19)	84.19 (79.67–87.85)	87.34 (81.13 – 91.71)	
Yes	9.68 (6.51–11.69)	6.96 (6.83–13.52)	8.76 (3.87 – 12.18)	
Does not know	5.98 (4.15–8.53)	6.13 (3.93–9.42)	5.70 (2.97 – 10.63)	
Parental CVD				0.422
Both	1.48 (0.73–2.92)	1.69 (0.75–3.70)	1.08 (0.26 – 4.23)	
Mother only	13.10 (10.50–16.21)	14.61 (11.29–18.68)	10.22 (6.59 – 15.50)	
Father only	8.67 (6.57–11.35)	7.58 (5.24–10.84)	10.75 (7.02 – 16.12)	
Neither	57.38 (53.16–61.49)	56.18 (50.95–61.26)	59.68 (52.42 – 66.52)	
Unknown	19.37 (16.25–22.92)	19.94 (16.10–24.43)	18.28 (13.33 – 24.54)	
Sibling CVD				0.795
No	88.25 (84.99–90.87)	88.71 (84.66–91.79)	87.34 (81.13 – 91.71)	
Yes	5.34 (3.63–7.79)	4.84 (2.93–7.88)	6.33 (3.42 – 11.41)	
Does not know	6.41 (4.51–9.02)	6.45 (4.19–9.80)	6.33 (3.42 – 11.41)	
Parental HTN				0.871
Both	10.52 (8.19–13.39)	10.39 (7.61–14.03)	10.75 (7.02 – 16.12)	
Mother only	31.55 (27.76–35.59)	30.02 (27.36–37.06)	30.65 (24.40 – 37.68)	
Father only	9.41 (7.21–12.17)	9.27 (6.65–12.76)	9.68 (6.16 – 14.87)	
Neither	29.34 (25.64–33.31)	28.09 (23.65–33.00)	31.72 (25.39 – 38.79)	
Unknown	19.19 (16.08–22.73)	20.22 (16.35–24.73)	17.20 (12.40 – 23.36)	
Sibling HTN				0.033
No	66.88 (62.47–71.00)	64.19 (58.67–69.35)	72.15 (64.59 – 78.62)	
Yes	23.50 (19.87–27.57)	27.10 (22.43–32.33)	16.46 (11.42 – 23.13)	
Does not know	9.62 (7.25–12.64)	8.71 (6.03–12.41)	11.39 (7.27 – 17.41)	
Parental DM				0.837
Both	2.21 (1.25–3.86)	1.97 (0.93–4.07)	2.69 (1.11 – 6.32)	
Mother only	15.13 (12.34–18.40)	15.73 (12.29–19.90)	13.98 (9.67 – 19.78)	
Father only	6.83 (4.98–9.28)	6.18 (4.09–9.21)	8.06 (4.90 – 12.98)	
Neither	52.40 (48.17–56.58)	51.97 (46.75–57.13)	53.23 (45.99 – 60.32)	
Unknown	23.43 (20.04–27.19)	24.16 (19.97–28.89)	22.04 (16.62 – 28.61)	
Sibling DM				0.187
No	76.66 (72.59–80.28)	74.76 (69.59–79.30)	80.38 (73.0 – 85.0)	
Yes	14.99 (12.02–18.53)	17.15 (13.33–21.79)	10.76 (6.76 – 16.68)	
Does not know	8.35 (6.15–11.23)	8.09 (5.51–11.71)	8.86 (5.29 – 14.45)	
Physical activity				0.903
Insufficient	86.42 (82.05–89.85)	86.93 (81.46–90.97)	85.44 (77.12 – 91.07)	
Moderate	11.59 (8.42–15.73)	11.06 (7.37–16.25)	12.62 (7.42 – 20.64)	
High	199 (0.89–4.36)	2.01 (0.75–5.26)	1.94 (0.47 – 7.54)	
Alcohol risk				<0.001
Normal	92.75 (90.06–94.75)	98.68 (96.53–99.53)	82.68 (76.37 – 87.57)	
High risk	2.90 (1.72–4.84)	0.66 (0.16–2.60)	10.61 (3.83 – 11.47)	
Alcohol use disorder	4.35 (2.84–6.58)	0.66 (0.16–2.60)	10.61 (6.85 – 16.08)	

[£] Median and IQR; *Mann–Whitney U test; p-value calculated using Student's t-test (parametric continuous variables); p-value calculated using χ^2 or Fisher's exact test (categorical variables); ARS: Subsidized Regime Administrators, CVD: Cardiovascular disease; DM: Diabetes Mellitus; EPS: Health Promoting Entities; HTN: hypertension; MI: myocardial infarction.

The overall prevalence of awareness of diagnosis was 61.68%, with a higher prevalence among women. Regarding treatment, 51.01% of participants previously diagnosed with HTN were receiving any antihypertensive medication, with a higher proportion among women. Finally, only 32.04% of treated individuals with HTN had controlled BP; the sex-specific trend was consistent with that observed for awareness of diagnosis and treatment **(Table 2)**.

Table 2. Overall prevalence of hypertension awareness, treatment, and control by sex.

Variable	Total n=543	Women n=356	Men n=187	p-value
		% IC 95%		
Awareness				0.001
No	38.31(34.28 – 42.52)	33.1(28.41 – 38.24)	48.35(41.12 – 55.64)	
Yes	61.68(57.47 – 65.71)	66.85(61.75 – 71.58)	51.64(44.35 – 58.87)	
Treatment				<0.001
No	48.98(44.79 – 53.19)	42.13(37.09 – 47.34)	62.03(54.82 – 68.74)	
Yes	51.01(46.80 – 55.20)	57.86(52.65 – 62.90)	37.96(31.25 – 45.17)	
Control				0.004
No	67.95(63.90 – 71.75)	63.76(58.62 – 68.61)	75.93(69.24 – 81.55)	
Yes	32.04(28.24 – 36.09)	36.23(31.38 – 41.37)	24.06(18.44 – 30.75)	

p-value calculated using the χ^2 test

In the multivariable model for awareness of diagnosis (**Table 3**), male sex was associated with a lower probability of awareness of HTN status (OR 0.61; 95% CI 0.40–0.93). Being married or cohabiting increased the probability of awareness of the diagnosis by more than 80% compared with being single (OR 1.88; 95% CI 1.10–3.22 and OR 1.86; 95% CI 1.01–3.41, respectively). Having a high risk of abdominal obesity was also associated with higher awareness of the diagnosis (OR 1.94; 95% CI 1.21–3.11). Participants who rated their health as fair or poor were more likely to be aware of their diagnosis than those who rated their health as excellent. Having health insurance increased the probability of awareness of diagnosis by 65% compared with being uninsured. Furthermore, not having a history of HTN in both parents was associated with a lower probability of awareness of diagnosis (OR 0.35; 95% CI 0.17–0.72). The model showed good fit (Hosmer–Lemeshow p=0.9793) and acceptable discrimination power (ROC 72.11%). Regarding the treatment outcome model, male sex was associated with a lower probability of receiving pharmacological treatment, whereas having health insurance and being evaluated during any follow-up period were variables associated with a higher probability of treatment. The model demonstrated excellent fit (Hosmer–Lemeshow p=0.9986) and good discrimination power (ROC 75.30%). In the control outcome model, a history of dyslipidemia was associated with a reduced probability of HTN control. In addition, participants assessed during follow-up assessments were more likely to have controlled BP than those identified at baseline. This model also demonstrated good fit (Hosmer–Lemeshow p=0.9718) and discrimination power (ROC 71.22%) (**Table 3**).

Table 3. Adjusted logistic regression models for awareness of hypertension diagnosis, antihypertensive treatment, and blood pressure control

Variable	HTN awareness		HTN treatment		HTN Control	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Age (years)	0.99 (0.97 – 1.01)	0.655	1.01 (0.98 – 1.04)	0.252	1.01 (0.97 – 1.03)	0.682
Sex						
Male vs female	0.61 (0.40 – 0.93)	0.024	0.43 (0.23 – 0.77)	0.005	0.96 (0.51 – 1.81)	0.919
Marital status						
Married vs. single	1.88 (1.10 – 3.22)	0.021				
Cohabiting vs. single	1.86 (1.01 – 3.41)	0.044				
Self-rated health						
Fair vs. excellent	3.53 (1.72 – 7.26)	0.001				
Poor vs. excellent	5.13 (1.82 – 14.43)	0.002				
Abdominal obesity						
Yes vs no	1.94 (1.21 – 3.11)	0.006				
Health insurance						
Insured vs. uninsured	1.65 (1.10 – 2.48)	0.015	2.12 (1.16 – 3.87)	0.013		
Parental history of HTN						
None vs. both parents	0.35 (80.17 – 0.72)	0.004				
Unknown vs. both parents	0.32 (0.15 – 0.71)	0.005				
Follow-up						
INEFAC I vs CARMEN			6.11 (2.27 – 16.44)	<0.001	2.66 (1.36 – 5.19)	0.004
INEFAC II vs CARMEN			8.11 (2.76 – 23.82)	<0.001	6.23 (2.95 – 13.14)	<0.001
History of dyslipidemia						
Yes vs no					0.45 80.25 – 0.82)	0.010
Goodness of fit	0.979		0.999		0.972	
ROC (%)	72.11		75.30		71.22	

OR: Odds ratio; 95% CI: 95% confidence interval; HTN: hypertension; ROC (%): Area under the receiver operating characteristic curve; p-value: statistical significance; INEFAC: Incidence of cardiovascular disease and its risk factors; CARMEN: Set of actions for the multifactorial reduction of noncommunicable diseases.

Discussion

This study identified advances in the awareness, treatment, and control of HTN in an urban population from lower-middle socioeconomic strata; although a substantial proportion of individuals are aware of their diagnosis and receive treatment, BP control remains limited. Factors associated with awareness of diagnosis were related to sociodemographic characteristics and access to the healthcare system, whereas treatment and control were influenced by health insurance coverage, participation in follow-up assessments, and the presence of comorbidities. Taken together, the findings reflect improvements in the detection and management of HTN, but also highlight the need to strengthen comprehensive strategies that ensure continuity of care, treatment adherence, and the management of coexisting risk factors.

HTN is one of the most prevalent modifiable risk factors for cardiovascular events and represents the third leading cause of death worldwide. Its burden varies across regions, which should be considered when designing prevention programs[13]. At the national level, efforts have been made to develop public policies that contribute to achieving global targets for reducing mortality from chronic non-communicable diseases. This study contributes to that agenda by describing the status of awareness, treatment, and control of HTN in an urban population, thereby strengthening the evidence base that underpins regional public health policies.

The results show that 61.68% of individuals with HTN were aware of their diagnosis, a proportion higher than the 46.5% reported by the PURE study[14], which similarly found a higher prevalence of awareness, treatment, and

control in urban areas. The prevalence of awareness of diagnosis aligns with that reported in the Southern Cone of Latin America (63.0%)[15], but it was lower than that reported in a study among patients attending a primary care service in Buenos Aires (86.9%)[16]. This highlights the differences observed between population-based studies and those conducted in healthcare settings, as well as the potential impact of primary care programs on improving HTN diagnosis.

Regarding the factors associated with awareness of the diagnosis, men had a 39% lower probability of being aware of their HTN status, consistent with the literature[17]. The association with sex has been explained by the presence of social stereotypes surrounding masculinity such as stoicism, self-sufficiency, and avoidance of vulnerability which translate into lower participation by men in health-promoting behaviors and in seeking healthcare[18,19].

Individuals who rated their health as fair or poor were more likely to be aware of their HTN diagnosis. This is consistent with a previous study conducted in a population from Dallas, Texas, which found that adults with HTN who perceived their health as good to excellent were less aware of their condition, likely due to the asymptomatic nature of HTN, which ultimately acts as a barrier to early detection and treatment[20]. This implies that educational efforts should promote regular medical check-ups, even among adults who appear to be in good health[20].

Having health insurance was associated with greater awareness of the HTN diagnosis. This may be explained by the fact that access to and continuity of care facilitate detection, whereas lack of insurance or intermittent coverage leads to irregular follow-up and lower awareness of the condition[21]. Likewise, being unaware of a parental history of HTN or not reporting HTN in either parent was associated with a lower probability of awareness of the diagnosis, a finding consistent with that reported in a population from Texas[20].

Abdominal obesity was associated with a higher probability of being aware of the HTN diagnosis, consistent with reports linking overweight and obesity to greater awareness of the disease and HTN treatment[22]. This may be explained by its multisystem adverse impact, which draws greater attention from both individuals and the healthcare system[23].

Regarding treatment prevalence, it was 51.01% among all individuals with HTN and 77.58% among those who were aware of their HTN diagnosis. These figures are comparable to those reported for the Colombian population included in the PURE study (46.6% and 77.5%, respectively)[24].

A total of 32.04% of all individuals with HTN and 60.16% of those receiving treatment had controlled BP. The prevalence of BP control was higher than that reported in the PURE study (17.3% and 37.01%, respectively)[24]. However, they are consistent with another local report by Herrera et al. in Cali (69.1%)[25]. Individuals with dyslipidemia had a lower probability of BP control, which is consistent with the frequent coexistence of HTN and dyslipidemia and their combined contribution to the risk of atherosclerotic disease, highlighting the need to implement an integrated approach to these and other risk factors to prevent cardiovascular diseases.

Given the cross-sectional nature of the data collected at three time points, an indicator variable for "follow-up" was included as a proxy to capture any unmeasured change (e.g., environment, diagnostic capacity, insurance coverage, access). This variable was significantly associated with treatment and control, suggesting that individuals identified during the two follow-up assessments had a higher probability of receiving treatment and achieving BP control than those identified at baseline. This may be due to increased health literacy resulting from participation in the cohort, as well as to the expansion of the health system's coverage, which likely facilitated access to pharmacological treatment and, consequently, HTN control.

Therapeutic inertia, or lack of treatment intensification, has been suggested as an explanation for uncontrolled HTN when first- or second-line antihypertensive medications fail to achieve targets[26]; this issue should be explored in future research. Medication adherence is another key determinant of HTN control[17], which was also not assessed in detail in this study; although a proxy variable based on self-report was created, its validity may be limited.

It should be noted that the baseline cohort included individuals residing in socioeconomic strata 2 and 3; therefore, there was limited variation in exposure to socioeconomic factors, which may explain the absence of associations with these variables. Although this study had a cross-sectional design, participants were drawn from a cohort; therefore, the probability of participation was modeled to mitigate potential selection bias. The models for each outcome were weighted by the probability of participation, which was not statistically significant and did not modify the regression coefficients by more than 10%, suggesting that participation was unlikely to bias the estimated associations.

Strengths and limitations

Although the data were collected before the implementation of MIAS–RIAS, the findings remain relevant to current cardiovascular risk management. The identified determinants, insurance coverage, continuity of care, and health literacy, continue to be pillars of the current comprehensive care-oriented model. Moreover, these results provide a useful baseline for assessing the impact of reforms on the timely diagnosis, treatment, and control of HTN in the country.

This study has several methodological strengths. It is based on a large population-based cohort with systematic follow-up, which enabled a detailed analysis of factors associated with HTN awareness, treatment, and control at different time points. In addition, standardized procedures for BP measurement were used, and multivariable models were adjusted for multiple clinical and sociodemographic covariates, thereby strengthening the internal validity of the findings. However, several limitations should be acknowledged. The analysis followed a cross-sectional design nested within a cohort, which precludes establishing causal or temporal relationships among variables. Partial reliance on self-reported data may introduce recall or social desirability bias, and the exclusion of participants with incomplete data may introduce selection bias. Likewise, the high prevalence of these outcomes may have led to an overestimation of associations due to the use of odds ratios rather than prevalence ratios; however, this limitation was considered in the interpretation of the results. Finally, the findings reflect the specific context of an urban Colombian population and should be extrapolated with caution to other settings with different epidemiologic and health insurance characteristics.

Conclusions

Men and individuals who perceive their health as good have a lower probability of being aware of their HTN diagnosis and of receiving treatment. Participants who remained in cohort follow-up were more likely to receive treatment and have controlled HTN, while dyslipidemia was associated with poorer HTN control. Prevention programs targeting apparently healthy individuals and men, along with comprehensive approaches to cardiovascular risk, are needed to improve HTN control rates and reduce the morbidity and mortality attributable to HTN.

Author contributions

MLA contributed to the conception and design of the study; data acquisition, analysis, and interpretation; drafting and critical revision of the manuscript for important intellectual content; final approval of the version to be published; and accountability for all aspects of the work. AHO contributed to the conception and design of the study; data acquisition, analysis, and interpretation; drafting and critical revision of the manuscript for important intellectual content; final approval of the version to be published; and accountability for all aspects of the work. EFMH contributed to the conception and design of the study; data acquisition, analysis, and interpretation; drafting and critical revision of the manuscript for important intellectual content; final approval of the version to be published; and accountability for all aspects of the work. SSG contributed to the conception and design of the study; data acquisition, analysis, and interpretation; drafting and critical revision of the manuscript for important intellectual content; final approval of the version to be published; and accountability for all aspects of the work. LMVC contributed to the conception and design of the study; data acquisition, analysis, and interpretation; drafting and critical revision of the manuscript for important intellectual content; final approval of the version to be published; and accountability for all aspects of the work.

Ethical considerations

The study was conducted in accordance with current clinical research regulations and was approved by the institutional Ethics Committee (CEI-2024-07724). Informed consent was obtained from all participants (R-MA102-05), in accordance with Resolution 008430 of 1993 issued by the Colombian Ministry of Health and with the principles set forth in the Declaration of Helsinki (1964), as amended in October 2013.

Conflict of interest

All authors declare that they have no conflicts of interest.

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Reference

1. Organización Mundial de la Salud. La OMS detalla, en un primer informe sobre la hipertensión arterial, los devastadores efectos de esta afección y maneras de ponerle coto. Organización Panamericana de la Salud. Disponible en: https://www.paho.org/es/noticias/19-9-2023-oms-detalla-primer-informe-sobre-hipertension-arterial-devastadores-efectos-esta

2. Zhou B, Bentham J, Di Cesare M, Bixby H, Danaei G, Cowan MJ, et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. Lancet. 2017; 389(10064): 37-55. doi: https://doi.org/10.1016/S0140-6736(16)31919-5

3. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control. Circulation. 2016; 134(6): 441-50. doi: https://doi.org/10.1161/CIRCULATIONAHA.115.018912

4. Gómez Jiménez A. Colombia: el contexto de la desigualdad y la pobreza rural en los noventa. Cuad Econ. 2003; 22(38): 199-238. Disponible en: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0121-47722003000100009

5. Dzudie A, Rayner B, Ojji D, Schutte AE, Twagirumukiza M, Damasceno A, et al. Roadmap to achieve 25% hypertension control in Africa by 2025. Glob Heart. 2018; 13(1): 45-59. doi: https://doi.org/10.1016/j.gheart.2017.06.001

6. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary. Hypertension. 2018; 71(6): 1269-324. doi: https://doi.org/10.1161/HYP.0000000000000066

7. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J. 2018; 39(33): 3021-104. doi: https://doi.org/10.1093/eurheartj/ehy339

8. National Guideline Centre (UK). Hypertension in adults: diagnosis and management. London: National Institute for Health and Care Excellence; 2019. Disponible en: https://www.ncbi.nlm.nih.gov/books/NBK547161/

9. Nerenberg KA, Zarnke KB, Leung AA, Dasgupta K, Butalia S, McBrien K, et al. Hypertension Canada's 2018 guidelines for diagnosis, risk assessment, prevention, and treatment of hypertension in adults and children. Can J Cardiol. 2018; 34(5): 506-25. doi: https://doi.org/10.1016/j.cjca.2018.02.022

10. Umemura S, Arima H, Arima S, Asayama K, Dohi Y, Hirooka Y, et al. The Japanese Society of Hypertension guidelines for the management of hypertension (JSH 2019). Hypertens Res. 2019; 42(9): 1235-81. doi: https://doi.org/10.1038/s41440-019-0284-9

11. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension global hypertension practice guidelines. Hypertension. 2020; 75(6): 1334-57. doi: https://doi.org/10.1161/HYPERTENSIONAHA.120.15026

12 Bromfield S, Muntner P. High blood pressure: the leading global burden of disease risk factor and the need for worldwide prevention programs. Curr Hypertens Rep. 2013; 15(3): 134-6. doi: https://doi.org/10.1007/s11906-013-0340-9

13. Gómez JF, Camacho PA, López-López J, López-Jaramillo P. Control y tratamiento de la hipertensión arterial: Programa 20-20. Rev Colomb Cardiol. 2019; 26(2): 99-106. doi: https://doi.org/10.1016/j.rccar.2018.06.008

14. Chow CK, Teo KK, Rangarajan S, Islam S, Gupta R, Avezum A, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. JAMA. 2013; 310(9): 959-68. doi: https://doi.org/10.1001/jama.2013.184182

15. Rubinstein AL, Irazola VE, Calandrelli M, Chen CS, Gutierrez L, Lanas F, et al. Prevalence, awareness, treatment, and control of hypertension in the Southern Cone of Latin America. Am J Hypertens. 2016; 29(12): 1343-52. doi: https://doi.org/10.1093/ajh/hpw092

16. Feldstein CA, Garrido D, Chavin JM, Liendo XM, de los Santos AR. Primary care survey of awareness and control of hypertension: a hospital-based study. Am J Ther. 2010; 17(3): 295-300. doi: https://doi.org/10.1097/MJT.0b013e3181bdc3f6

17. Victor RG, Leonard D, Hess P, Bhat DG, Jones J, Vaeth PA, et al. Factors associated with hypertension awareness, treatment, and control in Dallas County, Texas. Arch Intern Med. 2008; 168(12): 1285-93. doi: https://doi.org/10.1001/archinte.168.12.1285

18. Williams DR. The health of men: structured inequalities and opportunities. Am J Public Health. 2008; 98(Suppl 1): S150-7. doi: https://doi.org/10.2105/AJPH.98.Supplement_1.S150

19. Zhang Y, Moran AE. Trends in the prevalence, awareness, treatment, and control of hypertension among young adults in the United States, 1999 to 2014. Hypertension. 2017; 70(4): 736-42. doi: https://doi.org/10.1161/HYPERTENSIONAHA.117.09801

20. Zhou J, Fang S. Association between undiagnosed hypertension and health factors among middle-aged and elderly Chinese population. Int J Environ Res Public Health. 2019; 16(7): 1214. doi: https://doi.org/10.3390/ijerph16071214

21. Chijioke C, Anakwue R, Okolo T, Ekwe E, Eze C, Agunyenwa C, et al. Awareness, treatment, and control of hypertension in primary health care and secondary referral medical outpatient clinic settings at Enugu, Southeast Nigeria. Int J Hypertens. 2016; 2016: 1-5. doi: https://doi.org/10.1155/2016/5628453

22. Wei J, Mi Y, Li Y, Xin B, Wang Y. Factors associated with awareness, treatment and control of hypertension among 3579 hypertensive adults in China: data from the China Health and Nutrition Survey. BMC Public Health. 2021; 21(1): 364. doi: https://doi.org/10.1186/s12889-021-10417-4

23. Ahn S, Zhao H, Smith ML, Ory MG, Phillips CD. BMI and lifestyle changes as correlates to changes in self-reported diagnosis of hypertension among older Chinese adults. J Am Soc Hypertens. 2011; 5(1): 21-30. doi: https://doi.org/10.1016/j.jash.2010.12.001

24. Camacho PA, Gomez-Arbelaez D, Molina DI, Sanchez G, Arcos E, Narvaez C, et al. Social disparities explain differences in hypertension prevalence, detection and control in Colombia. J Hypertens. 2016; 34(12): 2344-52. doi: https://doi.org/10.1097/HJH.0000000000001115

25. Herrera R, Badiel M, Zapata H. Factores asociados al no control de la presión arterial en pacientes inscritos al programa de hipertensión de una entidad promotora de salud en Cali, Colombia, 2004. Rev Colomb Cardiol. 2009; 16(4): 143-52. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-56332009000400002

26. Olives C, Myerson R, Mokdad AH, Murray CJL, Lim SS. Prevalence, awareness, treatment, and control of hypertension in United States counties, 2001-2009. PLoS One. 2013; 8(4): e60308. doi: https://doi.org/10.1371/journal.pone.0060308