National cross-sectional data on coexisting prehypertension and prediabetes among adults in Ecuador

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ABSTRACT

INTRODUCTION The study aimed to estimate the prevalence and associated factors of coexisting prehypertension (PreHTN) and prediabetes (PreDM) among adults in Ecuador.

METHODS Cross-sectional data from the Ecuador STEPS 2018 survey were analyzed for 3608 persons, aged 18–69 years (median: 39; IQR: 25), who had complete blood glucose and pressure data, were non-pregnant, without cardiovascular disease, and responded to interview and physical and biomedical measures.

RESULTS Of the 3608 individuals, 247 (6.5%) had coexisting PreHTN and PreDM, 1353 (39.9%) had both normoglycemia and normotension, 823 (23.2%) had PreHTN only, and 321 (7.5%) had PreDM only. Compared to the group with both normoglycemia and normotension, older age (50–69 years), male sex, obesity, and elevated total cholesterol (TC) increased the risk, while having secondary education level decreased the risk of coexisting PreHTN and PreDM. Furthermore, compared to the group with both normoglycemia and normotension, older age (50–69 years), male sex, being Afro-Ecuadorian/Mulato, overweight, obesity, and elevated TC increased the risk, while Amerindian ethnicity decreased the risk of PreHTN only. Finally, compared to the group with both normoglycemia and normotension, older age (50–69 years), and elevated TC increased the risk, while being male, and secondary or higher education level decreased the risk of PreDM only.

CONCLUSIONS Almost one in ten adults in Ecuador had coexisting PreHTN and PreDM, and several associated factors were identified.

ABBREVIATIONS BMI: body mass index, BP: blood pressure, DM: diabetes, HTN: hypertension, NCD: non-communicable diseases, PreDM: prediabetes, PreHTN: prehypertension, STEPS: STEPwise approach to surveillance, TC: total cholesterol

INTRODUCTION

Prehypertension (PreHTN) is defined as systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg, and is between normal blood pressure and hypertension[1]; and prediabetes (PreDM) defined as fasting plasma glucose levels 5.6–6.9 mmol/L, is between normal blood glucose and DM[2]. People with PreHTN/PreDM are at high risk of developing HTN and DM[3,4], largely contributing to cardiovascular disease (CVD) and mortality[5-9].

The prevalence of coexisting PreHTN and PreDM was 11.3% (≥18 years) in Jilin Province in 2013, China[10], 11.0% (≥18 years) in northern and northeastern China in 2008–2010[11], 11.2% (≥20 years) in 1999 in USA[12], and 10.4% (adults) in Enugu state in 2013, Nigeria[13]. The prevalence of PreDM only was 4.3% and PreHTM only was 34.2% in Jilin Province, China[10]. In Peru in 2017–2018, the national prevalence of PreHTN was 21.1%[14]. Among overweight/obese people in a small community study in the inner-city of Portoviejo in 2010 (Ecuador), undiagnosed PreHTN, HTN, preDM, and DM were highly prevalent[15]. We could not identify any study on the national prevalence and associated factors of PreHTN/PreDM in the general adult population in Ecuador, which led to the study.

In previous studies, sociodemographic and health

factors were identified for coexisting PreHTN and PreDM. Sociodemographic factors associated with PreHTN/PreDM include older age[10-13,16], male sex[10,12,16], lower education[10], ethnicity (lowest in non-Hispanic African American[12]; lowest among Mongolian-Chinese[16]), and region[16]. The health factors associated with PreHTN/PreDM include physical inactivity[13], obesity[10-12,16], abnormal triglyceride (TG)[10,12,16], low-density lipoprotein cholesterol (LDL-C)[16], and lower high-density lipoprotein cholesterol[12].

Factors associated with PreHTN include older age[14], men[14,17,18], lower socioeconomic status[17-19], high salt intake[20], physical inactivity[17-19], low fruit and vegetable intake[17], smoking[17], alcohol use[17,19], obesity[14,17,18,20], abnormal triglycerides[14]. Factors associated with PreDM include older age[21], lower socioeconomic status[21], ethnicity[21,22], smoking, alcohol use, obesity[23], abnormal triglycerides[22], and normal total cholesterol[22,23]. The aim of the study was to assess the prevalence and associated factors of PreHTN/PreDM among people aged 18–69 years, in Ecuador.

METHODS

Setting

With a population of 17.5 million, Ecuador is an upper middle-income nation, 25% of which live in poverty. Mestizo (mixed White and Native American) makes up 71.9% of the population, followed by Montubio (7.4%), Native Americans 7%, Whites 6.1%, Afro-Ecuadorians 4.3%, Mulatto 1.9%, Blacks 1%, and Other 0.4%. With significant concentrations also found along the western coastal strip, almost half of the population is concentrated in the interior in the Andean intermontane basins and valleys; the eastern rainforests are still sparsely populated. The majority of people (64.8%) reside in urban areas; the life expectancy at birth for men and women was 75.3 and 81.3 years, respectively; among those aged >15 years, 94.9% of men and 94% of women could read and write[24].

Sample and procedure

We analyzed cross-sectional secondary data from the 2018 Ecuador STEPS survey[25], including participants with complete fasting blood glucose and blood pressure measurements. Participants with a self-reported history of heart attack/angina/stroke were excluded[26]. Using the 3 STEPS process, interviews, physical and biomedical measures were assessed[26]. A nationally representative community sample of participants aged 18–69 years (excluding Galapagos) was randomly selected through a stratified multistage sampling process[26]. Probability sampling scheme of elements was used with the following three selection stages: 1) First stage, selecting primary sampling units (PSUs) by layer; 2) Second stage: selecting 12 occupied residences within each PSU selected in the first phase; and 3) Third stage: selecting 1 person aged 18–69 years per household. The selection of PSUs, according to the established size, was conducted independently and randomly in each of the strata. They also randomly selected 12 homes from each previously selected cluster. Since the second period of uprising, given the high rate of change in occupation, 16 homes per cluster were chosen to counteract this effect. The change affected the remaining 230 conglomerates, which gave a total of 6680 residential areas to be examined. Finally, an enrolment of the eligible persons within each residence, selecting in a way random of them[26]. The Ecuador Ministry of Health Ethical Committee had provided ethics approval, and participants had given written informed consent.

Measures

For the STEPS key survey measures, construct validity and associative validity have been demonstrated, ensuring aggregate data suitable for reliable cross-country comparisons[27].

Outcome variables

PreHTN was defined as systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg; and HTN as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg or taking anti-hypertensive medication in the past two weeks[1,26]. Of the three systolic and diastolic blood pressure readings (participants rested for three minutes between each reading) obtained using the Omron BP apparatus automatic blood pressure monitor, the last two were averaged[26]. PreDM was defined as fasting plasma glucose levels 5.6–6.9 mmol/L; and DM ≥7.0 mmol/L or currently on medication for raised blood glucose[2].

Sociodemographic factors included education level, age, sex, ethnicity, and marital status[25]. Health risk behaviors included daily servings of fruits and vegetables, dietary salt intake (often or always adding salt/salty sauce before/during meals), smoking (daily), and alcohol dependence (3 items of the Alcohol Use Disorder Identification Test, scores ≥4)[28]. Physical activity was evaluated with the Global Physical Activity Questionnaire (GPAQ) and classified by median metabolic equivalent (MET) of the activities performed as low, moderate, and high[29]. Body mass index (BMI, kg/m^2) was classified as: underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), and obesity (≥30.0)[25,26]. Elevated total cholesterol (TC) was defined as: TC ≥5.17 mmol/L (200 mg/dL) or on antilipidemic medication[30].

Data analysis

Chi-squared tests were used to estimate differences in the proportion of outcome variables. Adjusted multinomial logistic regression was applied to assess the factors associated with PreHTN and PreDM, PreHTN only, and PreDM only (with both normoglycemia and normotension group as reference category). Covariates were selected based on literature review[10-13,16-23], and included sociodemographic factors (age, gender, ethnicity, education level, and marital status), health risk behaviors (fruit/vegetable intake, salt

Table 1. Classification of hypertension (HTN) and diabetes (DM), cross-sectional population survey, Ecuador, 2018 (N=3608)

Variable	Normal blood pressure	PreHTN	HTN	Total
	n (%)*	n (%)*	n (%)*	n (%)*
Normal blood glucose	1353 (39.9)	823 (23.2)	423 (12.0)	2603 (75.1)
PreDM	321 (7.5)	247 (6.5)	153 (3.9)	727 (17.9)
DM	79 (1.7)	104 (2.5)	105 (2.8)	291 (7.1)
Total	1753 (49.1)	1174 (32.2)	681 (18.7)	3608 (100)

*n is unweighted and % is weighted. PreHTN: systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg. HTN: systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg or taking anti-hypertensive medication in the past two weeks. PreDM: fasting plasma glucose levels 5.6–6.9 mmol/L. DM: ≥7.0 mmol/L or currently on medication for raised blood glucose.

intake, smoking, alcohol dependence, and physical activity), BMI, and elevated TC. The missing values were discarded and the significance was set at $p<0.05$. The sample with missing values differed from the complete data in terms higher education, but no other differences in relation to social and health characteristics. STATA software version 14.0 (Stata Corporation, College Station, TX, USA) was used for the statistical analysis taking account complex sampling.

RESULTS

Characteristics of the participants

The sample with complete blood pressure and glucose measurements, excluding pregnant women and those with cardiovascular disease, included 3608 adults, aged 18–69 years (median: 39; IQR: 25), in 2018. Of the 3608 individuals, 247 (6.5%) had coexisting PreHTN and PreDM, 1353 (39.9%) had normoglycemia and normotension, 823 (23.2%) had PreHTN only, and 321 (7.5%) had PreDM only (Table 1).

Compared to the group with both normoglycemia and normotension, the group of coexisting PreHTN and PreDM, the group of PreHTN only, and the group of PreDM only, differed in terms of age, sex, marital status, ethnicity, education level, daily smoking, physical activity, body mass index, and elevated TC (Table 2).

Multinomial regression results

Compared to the group with both normoglycemia and normotension, older age (50–69 years) (adjusted relative risk ratio, ARRR=5.91; 95% CI: 3.34–10.45), male sex (ARRR=3.16; 95% CI: 1.08–4.80), obesity (ARRR=4.05; 95% CI: 2.57–6.41), and elevated TC (ARRR=2.24; 95% CI: 1.54–3.26) increased the risk, while having secondary education (ARRR=0.51; 95% CI: 0.32–0.83) decreased the risk of coexisting PreHTN and PreDM. Furthermore,

Table 2. Normal, prehypertension (PreHTN) and prediabetes (PreDM), PreHTN only, and Pre DM only, cross-sectional population survey, Ecuador, 2018 (N=2744)

Variable	Sample	Normal	PreHTN and PreDM	PreHTN only	PreDM only	p[a]
	n (%)	n (%)	n (%)	n (%)	n (%)	
All	2744 (100)	1353 (51.8)	247 (8.5)	823 (30.1)	321 (9.6)	
Age (years)						<0.001
18–29	882 (36.6)	549 (64.7)	35 (3.8)	209 (24.2)	89 (7.3)	
30–49	1256 (41.7)	604 (50.2)	108 (8.0)	386 (31.3)	158 (10.5)	
50–69	606 (21.7)	200 (33.1)	104 (17.6)	228 (37.7)	74 (11.6)	
Gender						<0.001
Female	1639 (52.8)	909 (57.9)	122 (6.6)	359 (21.8)	249 (13.7)	
Male	1105 (47.2)	444 (45.1)	125 (10.7)	464 (39.3)	72 (5.0)	
Marital status						0.098
Not married	1279 (44.1)	651 (55.8)	106 (6.5)	390 (29.5)	132 (8.2)	
Married	1463 (55.9)	702 (48.7)	141 (10.2)	433 (30.6)	187 (10.6)	

Continued

Table 2. Continued

Variable	Sample	Normal	PreHTN and PreDM	PreHTN only	PreDM only	p[a]
	n (%)	n (%)	n (%)	n (%)	n (%)	
Ethnicity						0.014
Mestizo	2145 (79.5)	1060 (52.1)	196 (8.7)	636 (29.6)	253 (9.7)	
Amerindian	212 (6.6)	117 (60.8)	18 (7.2)	43 (19.6)	34 (12.4)	
Montubio	190 (6.7)	84 (44.1)	16 (9.9)	75 (37.0)	15 (8.9)	
Afro-Ecuadorian/Mulato	133 (4.4)	58 (38.7)	13 (9.1)	48 (46.3)	14 (5.9)	
Whites/Other	63 (2.8)	34 (63.2)	4 (3.7)	20 (25.4)	5 (7.7)	
Education level						<0.001
Lower than secondary	1391 (45.9)	618 (45.2)	145 (10.5)	438 (32.2)	190 (12.1)	
Secondary	610 (23.3)	324 (56.6)	39 (5.0)	184 (29.5)	63 (8.8)	
Higher than secondary	742 (30.8)	410 (57.7)	63 (8.3)	200 (27.4)	68 (6.5)	
Fruit/vegetables (servings)						0.563
0–1	1650 (59.2)	816 (50.7)	151 (8.4)	490 (30.9)	193 (10.0)	
2–3	833 (31.5)	401 (52.2)	76 (9.2)	249 (28.8)	107 (9.8)	
≥4	254 (9.3)	132 (57.6)	20 (7.2)	81 (29.0)	21 (6.2)	
Salt intake (often/always)						
No	2438 (88.2)	1195 (50.9)	224 (8.8)	739 (30.7)	280 (9.6)	
Yes	295 (11.8)	152 (57.5)	23 (6.9)	82 (25.9)	38 (9.7)	
Daily smoking						
No	2641 (96.3)	1315 (52.2)	231 (8.3)	781 (29.8)	314 (9.7)	
Yes	103 (3.7)	38 (41.9)	16 (14.4)	42 (38.0)	7 (5.6)	
Alcohol dependence						0.037
No	2440 (88.1)	1218 (52.3)	207 (8.1)	728 (30.0)	287 (9.7)	
Yes	304 (11.9)	135 (48.3)	40 (11.7)	95 (31.1)	34 (8.9)	
Physical activity (low)						0.144
No	2125 (76.3)	1040 (50.7)	200 (8.8)	649 (31.2)	236 (9.3)	
Yes	615 (23.7)	313 (55.4)	47 (7.8)	172 (26.3)	83 (10.5)	
Body mass index (kg/m^2)						<0.001
Normal	1035 (39.7)	614 (63.2)	65 (5.9)	239 (22.2)	117 (8.8)	
Underweight	44 (2.0)	30 (71.9)	0 (0.0)	7 (17.7)	7 (10.3)	
Overweight	1060 (38.5)	474 (46.4)	93 (8.1)	360 (35.1)	133 (10.4)	
Obesity	601 (19.8)	233 (37.2)	89 (15.6)	216 (37.8)	63 (9.4)	
Elevated total cholesterol						<0.001
No	2078 (77.2)	1104 (55.4)	150 (6.8)	602 (29.1)	222 (8.7)	
Yes	666 (22.8)	249 (39.4)	97 (14.6)	221 (33.4)	99 (12.6)	

a Based on chi-squared statistics. PreHTN: systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg. PreDM: fasting plasma glucose levels 5.6–6.9 mmol/L.

compared to the group with both normoglycemia and normotension, older age (50–69 years) (ARRR=2.43; 95% CI: 1.71–3.46), male sex (ARRR=3.14; 95% CI: 2.42–4.08), being Afro-Ecuadorian/Mulato (ARRR=2.24; 95% CI: 1.29–3.87), overweight (ARRR=2.03; 95% CI: 1.55–2.67), obesity (ARRR=3.07; 95% CI: 2.21–4.28), and elevated TC (ARRR=1.41; 95% CI: 1.07–1.85) increased the risk, while Amerindian ethnicity (ARRR=0.52; 95% CI: 0.35–0.78)

Table 3. Multinominal logistic regression with prehypertension (PreHTN) and prediabetes (PreDM), PreHTN only, and Pre DM only (with normal group as reference category), cross-sectional population survey, Ecuador, 2018 (N=2744)

Variable	PreHTN and PreDM	PreHTN only	PreDM only
	ARRR (95% CI)	ARRR (95% CI)	ARRR (95% CI)
Age (years)			
18–29 ®	1	1	1
30–49	1.87 (1.15–3.02)*	1.39 (1.06–1.83)*	1.31 (0.89–1.93)
50–69	5.91 (3.34–10.45)***	2.43 (1.71–3.46)***	2.20 (1.43–3.40)***
Gender			
Female ®	1	1	1
Male	3.16 (1.08–4.80)***	3.14 (2.42–4.08)***	0.56 (0.37–0.83)**
Marital status			
Not married ®	1	1	1
Married	1.17 (0.82–1.65)	0.85 (0.66–1.10)	1.18 (0.82 – 1.71)
Ethnicity			
Mestizo ®	1	1	1
Amerindian	0.68 (0.33–1.38)	0.52 (0.35–0.78)**	0.78 (0.41–1.47)
Montubio	0.90 (0.46–1.77)	1.12 (0.71–1.78)	0.80 (0.41–1.56)
Afro-Ecuadorian/Mulato	1.50 (0.68–3.30)	2.24 (1.29–3.87)**	0.82 (0.40–1.66)
Whites/other	0.31 (0.09–1.09)	0.70 (0.34–1.44)	0.69 (0.21–2.23)
Education level			
Lower than secondary ®	1	1	1
Secondary	0.51 (0.32–0.83)**	0.79 (0.59–1.06)	0.64 (0.42–0.99)*
Higher than Secondary	0.99 (0.65–1.51)	0.86 (0.65–1.13)	0.53 (0.35–0.79)**
Fruit/vegetables intake (servings)			
0–1 ®	1	1	1
2–3	1.10 (0.76–1.57)	0.90 (0.68–1.17)	0.96 (0.69–1.34)
≥4	0.75 (0.42–1.33)	0.83 (0.56–1.22)	0.65 (0.37–1.14)
Salt intake (often/always)			
No ®	1	1	1
Yes	0.83 (0.46–1.49)	0.83 (0.57–1.19)	1.06 (0.66–1.71)
Daily smoking			
No ®	1	1	1
Yes	1.70 (0.81–3.55)	1.21 (0.69–2.13)	1.01 (0.41–2.46)
Alcohol dependence			
No ®	1	1	1
Yes	1.38 (0.85–2.24)	0.83 (0.59–1.17)	1.59 (0.94–2.68)
Physical activity (low)			
No ®	1	1	1
Yes	0.74 (0.48–1.15)	0.82 (0.62–1.09)	0.95 (0.67–1.34)
Body mass index (kg/m^2)			
Normal ®	1	1	1
Underweight	-	0.69 (0.23–2.03)	1.30 (0.45–3.79)
Overweight	1.43 (0.95–2.17)	2.03 (1.55–2.67)***	1.25 (0.88–1.78)
Obesity	4.05 (2.57–6.41)***	3.07 (2.21–4.28)***	1.20 (0.76–1.89)
Elevated total cholesterol			
No ®	1	1	1
Yes	2.24 (1.54–3.26)***	1.41 (1.07–1.85)*	1.51 (1.07–2.14)*

ARRR: adjusted relative risk ratio. ®: Reference categories. PreHTN: systolic BP 120–139 mmHg and/or diastolic BP 80–89 mmHg. PreDM: fasting plasma glucose levels 5.6–6.9 mmol/L. *p<0.05. **p<0.01. ***p<0.001.

decreased the risk of PreHTN only. Finally, compared to the group with both normoglycemia and normotension, older age (50–69 years) (ARRR= 2.20; 95% CI: 1.43–3.40), and elevated TC (ARRR=1.51; 95% CI: 1.07–2.14) increased the risk, while being male (ARRR=0.56; 95% CI: 0.37–0.83), having secondary (ARRR=0.64; 95% CI: 0.42–0.99) and more than secondary education (ARRR=0.53; 95% CI: 0.35–0.79) decreased the risk of PreDM only (Table 3).

DISCUSSION

This national survey among adults (18–69 years) in Ecuador showed a prevalence of 6.5% coexisting PreHTN and PreDM, which appears lower than in Jilin Province, China (11.3%; ≥18 years)[10], in northern and northeastern China (11.0%; ≥18 years)[11], in the USA (11.2%; ≥20 years)[12], and in Nigeria (10.4%; adults)[13]. Furthermore, we found that the prevalence of PreHTN only (23.2%) and PreDM only (7.5%) was in terms of PreHTN only (34.2%) lower and in terms of PreDM only (4.3%) higher than in Jilin Province, China[10]. The lower prevalence of PreDM only in China can be attributed to the higher threshold for defining PreDM (IFG: 6.1–6.9)[6]. The high rates of PreHTN and PreDM in Ecuador may be an indication of the high rate of noncommunicable diseases (NCDs) (72%) that account for all deaths[31], reflecting the epidemiological transition.

We found that compared to the group with both normoglycemia and normotension, older age (50–69 years), male sex, obesity, and elevated total cholesterol (TC) increased the risk, while having secondary education decreased the risk of coexisting PreHTN and PreDM; older age (50–69 years), male sex, Afro-Ecuadorian/Mulato, overweight, obesity, and elevated TC increased the risk, while Amerindian ethnicity decreased the risk of PreHTN only; and older age (50–69 years), and elevated TC increased the risk, while being male, secondary or higher education level decreased the risk of PreDM only. Consistent with previous research[10-13,16], we found that older age, male sex, lower education level, obesity, and elevated TC increased the risk for coexisting PreHTN and PreDM. Adults with lower education level may have less focus on health and develop PreHTN/PreDM, calling for increased health education for this group[10]. Obesity and elevated TC increase both PreHTN and PreDM, calling for weight reduction and dietary programs[10]. Although some previous studies found ethnic differences[12,13,16] and an association between physical inactivity and coexisting PreHTN and PreDM, we did not find a significant association. Being obese is a pro-inflammatory condition that is often linked to extensive metabolic changes, such as insulin resistance and blood pressure dysregulation[32]. The main cardio-metabolic risk factors include, central obesity, raised triglycerides, reduced HDL-cholesterol, raised blood pressure, and raised fasting plasma glucose[33].

Furthermore, we found that older age (50–69 years), male sex, being Afro-Ecuadorian/Mulato, overweight and obesity, and elevated TC increased the risk, while Amerindian ethnicity decreased the risk of PreHTN only. Consistent with previous research[14,17,18,20], we found that older age, men, obesity, and elevated TC increased the risk of PreHTN. Compared to Mestizos, Amerindians had a lower chance of PreHTN, and being Afro-Ecuadorian/Mulato had a higher chance of PreHTN. Previous studies also identified that the rate of HTN was higher in Afro-Ecuadorians than in other ethnicities[34], and at all altitudes indigenous people had lower SBP and DBP compared to Mestizos[35], and Amerindians in Ecuador had low prevalence of atrial fibrillation, explained by racially determined short stature and frequent intake of oily fish in the diet[36]. The higher prevalence of PreHTN in men than women may be attributed to biological and social differences[37].

While former studies[17-19] found an association between physical inactivity and PreHTN, we found that low physical activity was not significantly associated with PreHTN. Furthermore, we did not find any significant association between lower education level, low fruit and vegetable intake, high salt intake and alcohol use, and PreHTN, as was found in previous research[17-20].

In terms of PreDM, we found that older age, and elevated TC increased the risk, and male sex, secondary or higher education level decreased the risk of PreDM. Consistent with some previous studies[21-23], we found that older age, lower education level, and elevated TC increased the odds of PreDM. Furthermore, unlike previous research[21-23], we did not find significant differences in the prevalence of PreDM in terms of ethnicity, obesity, daily smoking and alcohol use.

Considering that PreHTN and PreDM are reversible conditions[38], interventions are indicated, including lifestyle modification and pharmacological treatment[12,38,39]. Policy implications are that increased local awareness campaigns on PreHTN/PreDM, screening for PreHTN/PreDM to improve early identification and integrated care, including lifestyle interventions, are needed to reduce HTN and DM in Ecuador[40].

Limitations

The study was limited because of its cross-sectional design and some variables were assessed by self-report, and other variables such as lipid profile, a family history of HTN and DM, psychological distress, geographical regions, and residence status, were not assessed. A further limitation was that for some of the variables, such as ethnicity, the sample size for some of the response options was small.

CONCLUSIONS

Almost one in ten adults in Ecuador had coexisting PreHTN and PreDM, and several associated factors (older age, male sex, lower education level, obesity, and elevated TC) that can help guide interventions, were identified. The male sex was positively associated with PreHTN/PreDM and PreHTN only, but negatively associated with PreDM only. Compared to Mestizos, Amerindians had a lower chance of PreHTN only

and being Afro-Ecuadorian/Mulato had a higher chance of PreHTN only. Early detection and interventions to control both PreHTN and PreDM are indicated to prevent HTNH and DM from occurring.

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The data supporting this research are available from the following sources: link or DOI World Health Organization NCD Microdata Repository: URL: https://extranet.who.int/ncdsmicrodata/index.php/catalog.

AUTHORS' CONTRIBUTIONS
SP and KP conceived and designed the research, performed statistical analysis, drafted the manuscript and made critical revision of the manuscript for key intellectual content. The authors read and approved the final version of the manuscript, and have agreed to authorship and order of authorship for this manuscript.

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