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Factors associated with control of arterial hypertension in Francisco Morazán, Honduras

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Abstract: Hypertension constitutes a major public health problem in Honduras. In 2019, 34% of Hondurans had hypertension, but only one-third achieved blood pressure control. In limited-resource settings, health system limitations complicate chronic disease oversight. This study aimed to identify individual and facility-level factors associated with blood pressure control among patients with hypertension attending primary care centers in Francisco Morazán, Honduras. A cross-sectional study was conducted with 486 patients with hypertension from eight primary health care centers. Medical records from the six months preceding the November-December 2024 collection period were evaluated to examine hypertension control factors (< 140/90 mmHg). Multivariable logistic regression and multilevel modeling were employed to identify associated factors. Seeking other medical care outside the primary clinic was associated with higher odds of blood pressure control (adjusted odds ratio (aOR) = 5.09; $p < 0.001$). Referral to higher levels of care (aOR = 0.11; $p < 0.001$) and morbid obesity (aOR = 0.14; $p = 0.005$) were associated with lower odds of achieving hypertension control. Being female and exhibiting higher perceived disease severity showed positive trends; however, these decreased after multilevel adjustment. None of the facility-level variables reached statistical significance. Several patient-level factors were associated with blood pressure control, whereas no statistically significant facility-level associations were detected in this sample. Because only eight health centers were included, the facility-level analysis should be considered exploratory. Reinforcing obesity management protocols and strengthening referral systems may contribute to improving hypertension management.

***Keywords*:** hypertension, primary health care, multilevel analysis, Honduras, obesity

1. Introduction

Noncommunicable diseases (NCDs) disproportionately affect vulnerable populations, accounting for 43 million deaths worldwide in 2021. Unfortunately, 73% of these deaths occurred mainly in low- and middle-income countries (LMICs), where resources for managing chronic diseases are often limited. Cardiovascular diseases, cancer, chronic respiratory conditions, and diabetes mellitus are the primary causes of mortality associated with NCDs (*1*).

In Central America, Honduras faces a severe NCD-related crisis. Most deaths in this country are due to NCDs; by 2021, 47.7% of all deaths could be attributed to NCDs (*2*). The age-standardized NCD mortality rate in Honduras is 560 per 100,000 people, surpassing the rates of 440 in El Salvador, 310 in Nicaragua, and 440 in Guatemala (*3*). Ischemic heart disease, stroke, and kidney disease are among the top ten causes of death in Honduras and represent major NCD-related conditions closely linked to poorly controlled hypertension (*2*).

Arterial hypertension is a major risk factor for cardiovascular and renal disease (*4,5*). Prompt diagnosis and treatment are important to reduce NCD mortality. Despite health system efforts, hypertension control remains deficient in Honduras. In 2019, prevalence of hypertension among adults aged 30–79 years reached 34%, but only 33% of those diagnosed achieved adequate blood pressure (BP) control (*6*). This finding suggests persistent barriers to effective management.

In limited-resource settings such as Honduras, health systems experience financial and human resource shortages, rendering control of chronic conditions especially challenging. The Honduran public health sector, which covers approximately 60% of the population, is characterized by a fragmented structure with different management capacities (*7*). The primary health system is organized into units of varying complexity, such as integrated health centers (*Spanish: centro integral de salud; CISs*) and primary health care units (*Spanish: unidad de atención primaria en salud; UAPSs*) (*8*). Although these facilities typically include a physician, these units often suffer from poor communication both among themselves and with higher levels of care, limiting chronic disease management.

The Honduran health system is transitioning from a centralized to a decentralized model. In this framework, authority over decentralized facilities may be vested in local governments or nongovernmental organizations (NGOs), while centralized units remain under the direct control of the Ministry of Health (*9*). However, this transition has been slow. Consequently, only a minority of health care centers currently operate under a decentralized model.

Because hypertension control is multifactorial, few studies in Honduras have focused on exploring possible factors from both patient and health facility perspectives (*10,11*). Many studies may neglect behavioral factors that are associated with disease management in real-world settings (*12,13*).

This study aimed to identify factors associated with insufficient hypertension control in primary care centers (CISs and UAPSs) in Francisco Morazán, Honduras. By addressing these knowledge gaps, this research provides evidence to support design of more efficient, context-specific interventions and improved resource allocation, ultimately contributing to reducing the high burden of NCDs in the country.

2. Materials and Methods

2.1. Study design, setting and sampling procedures

A cross-sectional study was conducted in the department of Francisco Morazán, Honduras. Data collection occurred between November and December 2024, and medical records from the preceding six-month period were evaluated. A two-stage cluster sampling method was employed. The study was conducted in collaboration with the Central American Technological University (UNITEC), Honduras, the Francisco Morazán Departmental Health Region, and participating primary healthcare centers, which provided administrative support, and access to the study sites.

At the first stage, eight primary health centers were randomly selected from 21 eligible facilities (CISs and UAPSs) located in the study area. Eligibility criteria for these facilities included having at least one general practitioner on staff and sufficient physical accessibility for data collection. The specific characteristics of the eight selected facilities; including their administration type (centralized *vs.* decentralized) and geographic zone, are summarized in Table 1.

At the second stage, individual participants were selected *via* simple random sampling from daily clinical attendance lists using a computer-generated random sequence. Sampling flow is shown in Figure 1, which reveals selection of health centers and subsequent inclusion of hypertensive patients.

Sample size was determined using Cochran's model and was based on an expected prevalence of controlled hypertension of 33% (*6*), a 95% confidence level, and a 5% margin of error, which yielded an initial sample size of 340 participants. To account for the cluster sampling design, a design effect (Deff) of 1.30 was applied. Furthermore, the total was increased by 10% to account for potential nonresponses or incomplete records, resulting in a final target sample of 490 participants. To ensure representativeness across centers with varying patient volumes, the sample was distributed *via* proportional allocation on the basis of monthly hypertensive patient volume of each facility.

Patients were eligible for inclusion if they were 18 years old or older, had a confirmed diagnosis of arterial hypertension at least six months prior to the study, and resided within the area of the participating health center. Exclusion criteria included clinical factors, such as pregnancy, cognitive impairments, or lack of clinical evaluation at the facility within the past six months, and logistical factors, specifically medical records lacking essential contact information needed for patient follow-up.

2.2. Study variables and measurement

The primary outcome was BP control status, classified as controlled or uncontrolled. In accordance with the National Hypertension Management Protocol of the

Table 1. Facility-level structural capacity, clinical workload, and patient hypertension control status

Geographic Zone	Level of Care (UAPS/CIS)	Type of Administration	Medical Staff	Workload (Patients/ Doctor/Day)	Hypertensive Participants (*n*)	Proportion Controlled (%)
Center A	UAPS	Centralized	4	10–19	42	64.29
Center B	CIS	Centralized	17	30–39	188	26.06
Center C	UAPS	Centralized	3	10–19	57	56.14
Center D	UAPS	Centralized	3	10–19	32	50.00
South E	UAPS	Decentralized	3	20–29	69	53.62
South F	CIS	Decentralized	14	20–29	46	54.35
South G	CIS	Decentralized	10	20–29	26	42.31
South H	CIS	Decentralized	11	40–49	26	61.54

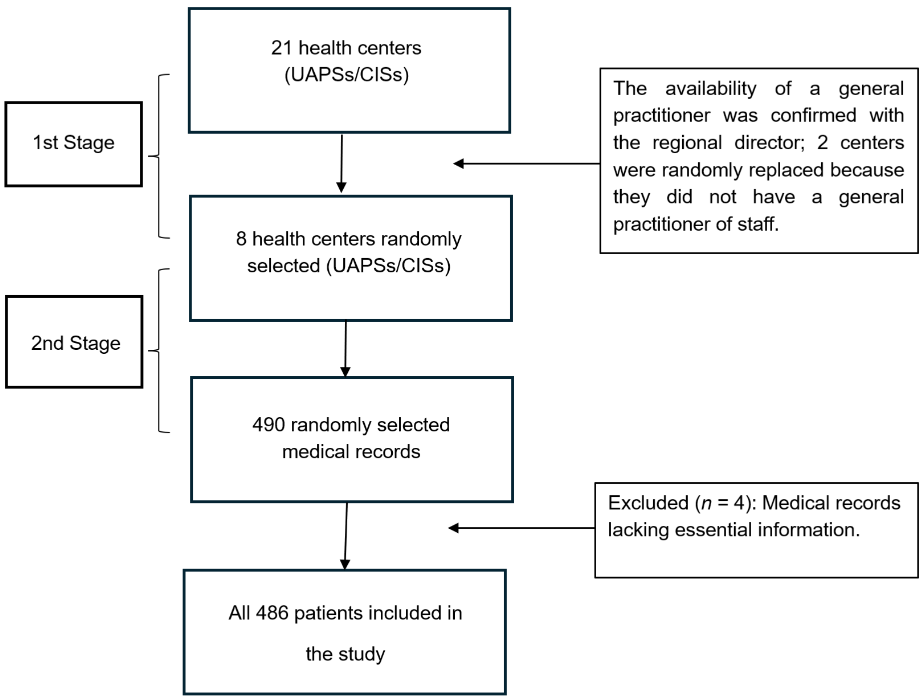

Figure 1. Flowchart of the study selection and participant enrollment process. This flowchart illustrates a multisampling method. Twenty-one potential health centers were initially selected, and 8 were randomly selected. Following administrative verification with the regional director, two centers were randomly replaced because of the absence of a general practitioner. A total of 490 medical records were screened for eligibility. Four records were excluded because of incomplete essential clinical data. The final analysis included a total of 486 medical records and their corresponding participants.

Secretariat of Health of Honduras (*14*), a therapeutic target of < 140/90 mmHg was established. BP control was assessed using BP measurements recorded during the most recent three months of follow-up. Medical records from the most recent six months were reviewed for each participant. BP control was determined using the mean of all BP measurements available during the most recent three-month evaluation period within this six-month review window. When more than one BP measurement was available, the average of all recorded measurements was calculated. If only one BP measurement was available during the three-month period, that measurement was used for classification. Therefore, at least one BP measurement during the most recent three-month period was required, whereas BP measurements were not required for each month within that period. Although the national protocol recommends stricter targets for patients at greater cardiovascular risk, a fixed target was applied in this study. This adjustment was selected because of limited availability of lipid profile data in primary care settings, which prevented formal cardiovascular risk stratification for all participants. Additionally, pulse pressure was analyzed as a clinical indicator of arterial stiffness. Pulse pressure was calculated as the difference between the systolic and diastolic BP values. To ensure a stable measurement of chronic BP burden, an average pulse pressure was derived from all clinical records available for each participant over the six-month study period.

Collected data included variables at both the health facility and patient levels. At the facility level, structural factors were assessed through structured interviews with the physicians in charge. Prevention and promotion activities were measured *via* a study-specific composite score (range: 4–36) developed on the basis of institutional assessment tools for NCDs. This score evaluated community and clinical prevention strategies. Owing to the lack of established thresholds, scores were categorized as low (< 18), moderate (18–27), or high (> 27) by dividing the score range into equal segments to facilitate group comparison.

Availability of medication was determined by the physical presence of six essential drug classes for hypertension on the survey day, following the World Health Organization (WHO) Package of Essential Noncommunicable (PEN) Disease Interventions (*15*). Similarly, technology and infrastructure were evaluated according to WHO-PEN guidelines, with a focus on essential diagnostic instruments for laboratory, preclinical, and clinical areas.

At the patient level, socioeconomic status (SES) was assessed through a modified SES Short-Form Questionnaire (SES-SQ) (*16*). Individual autonomy was assessed using Partners for Applied Social Sciences (PASS) health-seeking behavior model (*17*), which focuses on decision-making power under social and economic constraints. Pluralistic treatment-seeking was assessed separately and included use of home remedies, traditional treatments, and biomedical care. Lifestyle factors and self-care practices, including physical activity, salt intake, tobacco use, and alcohol consumption, were evaluated on the basis of the National Hypertension Protocol of Honduras (*14*). Medication adherence was assessed *via* a self-report scale adapted from the Morisky and Hill-Bone instruments (*18*). Furthermore, service quality was measured with a modified Primary Care Satisfaction Scale (PCSS) (*19*). Finally, dimensions of illness interpretation, pluralistic treatments, and health system navigation (referrals and attendance at other facilities) were included to account for external factors associated with BP control.

Data were collected through three structured instruments (A, B, and C) involving medical record extraction and face-to-face or telephone interviews. All the instruments were designed in English, translated into Spanish by the principal investigator, and pilot-tested at a rural health center. Field data collection was led by the principal investigator, a Honduran physician, with support of three trained Honduran nurses recruited as research assistants. The principal investigator and trained research assistants conducted participant interviews and obtained informed consent prior to data collection. Written informed consent was obtained during face-to-face interviews, fingerprint consent was used for participants unable to read or write after the consent form had been read aloud, and verbal informed consent was obtained only for telephone interviews when in-person interviews were not feasible because of participants' remote residence. Medical records were reviewed using standardized data collection procedures. Data collection was conducted in Spanish by the principal investigator and trained research assistants.

Participation was voluntary and involved minimal risk. Participants were informed that they could withdraw from the research without repercussions. To ensure anonymity, data were coded, redacted, and stored in a password-protected cloud drive or under lock and key at UNITEC.

2.3. Statistical analysis

The final analytical sample comprised 486 participants after excluding individuals with incomplete data for variables of interest. Statistical analysis was conducted using Stata/SE version 18.0. A descriptive analysis was implemented to summarize clinical, demographic, and behavioral characteristics of the participants, with categorical variables expressed as absolute frequencies and percentages. The analytical phase followed a three-stage approach including bivariable, multivariable, and multilevel logistic regression analyses. A significance level of $p < 0.05$ was established, with p-values reported to three decimal places.

At the first stage, bivariable logistic regression was employed to estimate crude associations between patient-level independent variables and BP control, and crude odds ratios (ORs) and 95% confidence intervals (CIs) were reported. Facility-level variables were excluded from this bivariable stage to avoid unreliable estimates due to the small number of clusters (n = 8). At the second stage, to identify independent factors associated with BP control, a multivariable logistic regression model was developed. Variables showing significant associations in bivariable analyses were considered for inclusion in the multivariable and multilevel models. Variables retained a priori based on established clinical relevance and previous evidence included age, socioeconomic status, smoking status, physical activity, salt intake, and treatment adherence. Multicollinearity was assessed using the generalized variance inflation factor (GVIF), and only variables with GVIF values < 2.0 were retained in final models. Missing data were handled using a complete-case approach, and participants with incomplete information for variables included in regression models were excluded.

Sparse categories were assessed during model development. Individual comorbidities with small numbers were summarized descriptively and were not included separately in regression models; instead, a binary variable indicating presence of any comorbidity was used. Body mass index (BMI) categories were retained according to clinically established thresholds to preserve clinically meaningful differences across BMI levels. Referral variables were analyzed separately according to their source (medical records or patient reports). Because the ≥ 5 consultations category included only five participants, a sensitivity analysis combining this group with the 3–4 consultations category was performed; however, the original three-category classification was retained because the alternative categorization did not alter overall interpretation of the findings and preserved clinically meaningful consultation frequency groups.

Finally, multilevel logistic regression analysis was conducted using a random-intercept model, with the eight health centers included as the clustering unit to account for the hierarchical structure of the data. Apparent discriminatory performance of the final model was assessed using the area under the receiver operating characteristic curve (AUC-ROC).

2.4. Ethical approvals

The study protocol received formal ethical approval from the Institutional Review Board of the School of Tropical Medicine and Global Health, Nagasaki University (Approval No. NU_TMGH_2024_305_1; approved on September 6, 2024), and Research Ethics Committee of UNITEC, Honduras (IRB00012967, Act No. 011-2024; approved on September 30, 2024).

In addition, administrative permission to conduct the study at the selected primary healthcare centers was granted on November 19, 2024, by the Francisco Morazán

Departmental Health Region of Ministry of Health of Honduras (Official Letter No. 809-2024-JRSFM). Ethical approvals covered participant recruitment, informed consent, medical record review, protection of participant privacy and confidentiality, and subsequent data analysis by the research team, while the administrative authorization permitted study implementation within participating health facilities.

3. Results

3.1. Characteristics of the study population and bivariable analysis of hypertension control

A total of 486 clinically diagnosed patients with hypertension under active pharmacological treatment were included in the final analytical sample. Of these, 213 (43.8%) had controlled blood pressure and 273 (56.2%) had uncontrolled blood pressure. As indicated in Table 1, significant variability in BP control was observed across centers. Center A and South H achieved the highest control rates (> 60%), whereas Center B, the facility with highest patient volume, achieved the lowest control rate (26.06%). Facilities with lower patient-to-doctor ratios (10–19 patients/day) generally had higher BP control rates than those with heavier workloads (30–49 patients/day). Patients managed under decentralized administration and those receiving UAPS-level care demonstrated higher proportions of BP control (53.29% and 56.00%, respectively).

The study population was predominantly female (78.2%), aged 60 years or older (52.9%), and exhibited a low socioeconomic status (70.4%). Bivariable analysis (Table 2) showed that sex was a significant factor, with women being 1.6 times more likely to achieve BP control than men. With respect to illness perception, patients who viewed hypertension as a severe condition attained twice the odds of BP control than those who perceived it as mild (OR: 2.21; 95% CI: 1.39–3.51).

Several clinical variables were strongly associated with insufficient BP control. BMI was strongly associated with uncontrolled hypertension. Notably, patients with morbid obesity (BMI ≥ 40) exhibited 88% lower odds of control (OR: 0.12; 95% CI: 0.03–0.37) than those with normal weight. Similarly, a pulse pressure ≥ 60 mmHg and the presence of any comorbidity (OR: 0.67) were significantly associated with lower odds of BP control.

Health care utilization patterns revealed mixed associations. Frequent consultations (3–4 in six months) were associated with lower BP control (OR: 0.38), whereas patients who sought other medical care beyond their routine follow-ups were four times more likely to achieve BP control (OR: 4.0; 95% CI: 2.63–6.08). Neither medication adherence, salt intake, nor the use of pluralistic treatments was significantly associated with BP control in this population. While 6.8% of patients reported being referred to higher levels of care, no counter referrals were recorded from hospitals back to the primary health centers. These variables included sex, body mass index (BMI), any comorbidity, severity of illness, number of medical consultations, other medical care, and referral according to patient report.

3.2. Multivariable analysis of hypertension control

Multivariable logistic regression results are presented in Table 3. After adjusting for potential confounders, several clinical and patient-related factors remained significantly associated with BP control. Compared to male patients, female patients were significantly more likely to achieve hypertension control (adjusted odds ratio (aOR) = 1.77; 95% CI: 1.01–3.15; $p = 0.047$). In terms of BMI, a clear inverse relationship was observed between obesity and BP control; patients with Class I obesity (aOR = 0.42; $p = 0.006$), Class II obesity (aOR = 0.35; $p = 0.020$), and Class III obesity (aOR = 0.14; $p = 0.004$) attained significantly lower odds of hypertension control than those with normal BMI.

The use of other medical care services showed the strongest positive association with BP control (aOR = 5.15; 95% CI: 3.10–8.78; $p < 0.001$). Conversely, patients with a history of referral to higher levels of care exhibited significantly lower odds of achieving BP control (aOR = 0.11; 95% CI: 0.04–0.31; $p < 0.001$). Other factors, including age group, smoking status, physical activity, and socioeconomic status, were not significantly associated with hypertension control in the multivariable model.

3.3. Multilevel analysis of hypertension control

The multilevel model produced findings consistent with the multivariable analysis for the primary factors associated with hypertension control, although certain patient-level associations were attenuated after the clustering effect of health centers was accounted for (Table 4). The estimated variance of the health center level random intercept was 0, indicating no evidence between center variation. Factors such as receiving other medical care and patient referrals remained highly significant. Specifically, patients receiving additional medical care had five times higher odds of BP control (aOR = 5.09; 95% CI: 2.98–8.70; $p < 0.001$), while patients with a history of referral to higher levels of care were significantly less likely to achieve BP control (aOR = 0.11; 95% CI: 0.04–0.33; $p < 0.001$). The association between BMI and BP control remained generally consistent across both models, with higher obesity categories being associated with lower odds of BP control, particularly in the morbid obesity group (aOR = 0.14; 95% CI: 0.03–0.54; $p = 0.005$).

In contrast, several variables that were statistically significant in the multivariable model (not accounting for the cluster effect) revealed attenuated associations

Table 2. Characteristics and factors associated with blood pressure control in hypertensive patients

Variable	*n*	(%)	Controlled, *n* (%)	OR (95% CI)	*p*-value
Age					
18–39	39	8.0	18 (46.2)	Reference	–
40–59	190	39.1	92 (48.4)	1.09 (0.55–2.19)	0.796
≥ 60	257	52.9	103 (40.1)	0.78 (0.40–1.54)	0.473
Female	380	78.2	176 (46.3)	1.61 (1.03–2.51)	0.037
Socioeconomic Status (SES-SQ Modified)					
Low	342	70.4	153 (44.7)	Reference	–
Middle	126	25.9	51 (40.5)	0.84 (0.55–1.27)	0.410
High	18	3.7	9 (50.0)	1.23 (0.48–3.19)	0.662
Quality of Service					
Poor	9	1.9	3 (33.3)	0.63 (0.16–2.57)	0.520
Moderate	112	23.0	49 (43.8)	0.99 (0.64–1.51)	0.940
High	365	75.1	161 (44.1)	Reference	–
Decision Power					
Moderate	249	51.2	103 (41.4)	Reference	–
Low	101	20.8	52 (51.5)	1.50 (0.94–2.39)	0.085
High	136	28.0	58 (42.6)	1.05 (0.69–1.60)	0.807
Illness Interpretation					
Severity of Illness					
Mild	111	22.8	36 (32.4)	Reference	–
Moderate	107	22.0	39 (36.4)	1.19 (0.68–2.09)	0.533
Severe	268	55.1	138 (51.5)	2.21 (1.39–3.51)	0.001
Susceptible to Complications	401	82.5	184 (45.9)	1.64 (1.00–2.67)	0.048
Knowledge of Illness Causes					
Does not know	257	52.9	121 (47.1)	Reference	–
Lifestyle	142	29.2	54 (38.0)	0.68 (0.45–1.05)	0.082
Genetics	30	6.2	14 (46.7)	0.98 (0.46–2.09)	0.966
Others (anxiety, stress, *etc.*)	57	11.7	24 (42.1)	0.82 (0.46–1.46)	0.496
Number of Medical Consultations (Last 6 Months)					
1–2 consultations	259	53.3	141 (54.4)	Reference	–
3–4 consultations	222	45.7	69 (31.1)	0.38 (0.26–0.55)	< 0.001
≥ 5 consultations	5	1.0	3 (60.0)	1.26 (0.21–7.06)	0.805
Average BMI					
< 18.5	8	1.6	4 (50.0)	0.84 (0.19–3.68)	0.820
18.5–24.9	138	28.4	75 (54.3)	Reference	–
25.0–29.9	157	32.3	73 (46.5)	0.73 (0.46–1.15)	0.170
30.0–34.9	121	24.9	45 (37.2)	0.50 (0.30–0.81)	0.005
35.0–39.9	38	7.8	13 (34.2)	0.44 (0.20–0.91)	0.027
≥ 40	24	4.9	3 (12.5)	0.12 (0.03–0.37)	< 0.001
Average Pulse Pressure					
< 60 mmHg	393	80.9	202 (51.4)	Reference	–
≥ 60 mmHg	93	19.1	11 (11.8)	0.13 (0.07–0.25)	< 0.001
Comorbidity					
Type 2 diabetes	137	28.2	58 (42.3)	0.92 (0.61–1.37)	0.680
Renal disease*	3	0.6	0 (0.0)	-	–
Previous stroke	8	1.6	3 (37.5)	0.77 (0.18–3.24)	0.717
Heart failure*	1	0.2	1 (100)	–	–
Ischemic heart disease	5	1.0	2 (40.0)	0.85 (0.14–5.15)	0.863
Others (prediabetes, obesity, *etc.*)	46	9.5	11 (23.9)	0.37 (0.18–0.75)	0.006
Any comorbidity	178	36.6	67 (37.6)	0.67 (0.43–0.98)	0.037
Previous Referrals (According to Medical Record)	10	2.1	1 (10.0)	0.14 (0.01–0.75)	0.062
Previous Referrals (According to Patient)	33	6.8	6 (18.2)	0.26 (0.11–0.65)	0.004
Other Medical Care	139	28.6	94 (67.6)	4.00 (2.63–6.08)	< 0.001

*Statistical comparison is limited because of the small number of patients; no *p*-value or confidence interval is reported. No significant associations were obtained for smoking, alcohol consumption, salt intake, physical activity, or medication adherence (all $p > 0.05$).

in multilevel analysis. Female sex, which demonstrated a significant association in the non-adjusted model ($p = 0.047$), shifted to marginally significant after accounting for the effect of health center clustering (aOR = 1.69; 95% CI: 0.95–3.01; $p = 0.072$). Similarly, the association for 3–4 consultations ($p = 0.294$) was no longer statistically significant after accounting for clustering at the health-center level. A sensitivity analysis combining the 3–4 and ≥ 5 consultation categories yielded similar findings. Although the association became statistically significant in the multivariable model, it remained non-significant in the multilevel model and therefore did not alter overall interpretation of the study findings. The original three-category classification was retained because it represents clinically meaningful consultation frequencies. No facility-level variables reached statistical

Table 3. Multivariable analysis of patient factors associated with hypertension control

Patient-related factors	Crude OR	Adjusted OR	95% CI	*p*-value
Age				
18–39 years old	Reference	Reference	–	–
40–59 years old	1.09	0.95	0.42–2.21	0.910
≥ 60 years old	0.78	0.49	0.20–1.16	0.104
Gender				
Male	Reference	Reference	–	–
Female	1.61	1.77	1.01–3.15	0.047
Average BMI				
< 18.5	0.84	0.56	0.10–3.19	0.506
18.5–24.9	Reference	Reference	–	–
25.0–29.9	0.73	0.72	0.42–1.23	0.233
30.0–34.9	0.50	0.42	0.23–0.77	0.006
35.0–39.9	0.44	0.35	0.14–0.83	0.020
≥ 40	0.12	0.14	0.03–0.47	0.004
Smokers				
Never	Reference	Reference	–	–
Used to smoke	1.07	2.19	0.92–5.19	0.073
Passive smokers	1.32	1.33	0.74–2.41	0.341
Active smokers	2.71	3.10	0.50–26.6	0.244
Frequency of Physical Activity				
No	Reference	Reference	–	–
Yes	1.36	1.30	0.82–2.08	0.269
Adherence to Treatment				
Low adherence	Reference	Reference	–	–
Moderate adherence	0.80	0.78	0.42–1.45	0.426
High adherence	0.80	0.89	0.46–1.73	0.724
Salt Intake				
< 1 teaspoon of salt	Reference	Reference	–	–
≥ 1 teaspoon of salt	1.10	1.03	0.66–1.61	0.882
Does not know	1.30	1.33	0.54–3.24	0.535
Any Comorbidity				
No comorbidity	Reference	Reference	–	–
Any comorbidity	0.67	0.93	0.60–1.47	0.769
Socioeconomic Status				
Low	Reference	Reference	–	–
Middle	0.84	0.93	0.56–1.57	0.800
High	1.23	0.93	0.26–3.30	0.908
Severity of Illness				
Mild	Reference	Reference	–	–
Moderate	1.19	1.00	0.53–1.90	0.999
Severe	2.21	1.68	0.98–2.92	0.062
Number of Medical Consultations				
1–2 consultations	Reference	Reference	–	–
3–4 consultations	0.38	0.57	0.37–0.90	0.015
≥ 5 consultations	1.26	1.07	0.13–10.54	0.948
Other Medical Care				
No	Reference	Reference	–	–
Yes	4.00	5.15	3.10–8.78	< 0.001
Referrals (According to the patient)				
No	Reference	Reference	–	–
Yes	0.26	0.11	0.04–0.31	< 0.001

Crude and adjusted odds ratios were calculated using the same complete-case analytical sample (n = 486; 213 participants with controlled blood pressure and 273 with uncontrolled blood pressure).

significance; these findings should be interpreted as exploratory given the limited number of health centers included in the analysis. The multilevel model demonstrated acceptable discriminatory performance, with an AUC-ROC value of 0.79 (95% CI: 0.75–0.83).

4. Discussion

The multilevel analysis identified several patient-level factors associated with hypertension control among primary care patients in Francisco Morazán, Honduras, including attending other medical care, referral to higher levels of care, and obesity. No statistically significant facility-level associations were detected in this sample. However, given the limited number of health centers included, these findings should be interpreted as exploratory.

A critical finding was that patients seeking care at

Table 4. Multilevel logistic regression: Patient-level and health center-level variables

Level	Variable	Adjusted OR	95% CI	*p*-value
Individual level (1st level)	Age			
	18–39 years old	Reference	–	–
	40–59 years old	0.99	0.42–2.33	0.979
	≥ 60 years old	0.52	0.21–1.26	0.150
Individual level (1st level)	Gender			
	Male	Reference	–	–
	Female	1.69	0.95–3.01	0.072
Individual level (1st level)	Average BMI			
	< 18.5	0.58	0.10–3.29	0.538
	18.5–24.9	Reference	–	–
	25.0–29.9	0.71	0.41–1.23	0.220
	30.0–34.9	0.43	0.23–0.79	0.007
	35.0–39.9	0.37	0.15–0.91	0.031
	≥ 40	0.14	0.03–0.54	0.005
Individual level (1st level)	Smokers			
	Never	Reference	–	–
	Used to smoke	2.30	0.95–5.54	0.064
	Passive smokers	1.33	0.72–2.48	0.364
	Active smokers	2.60	0.40–17.0	0.280
Individual level (1st level)	Frequency of Physical Activity			
	No	Reference	–	–
	Yes	1.30	0.81–2.09	0.280
Individual level (1st level)	Adherence to Treatment			
	Low adherence	Reference	–	–
	Moderate adherence	0.82	0.44–1.55	0.543
	High adherence	0.93	0.47–1.85	0.845
Individual level (1st level)	Salt Intake			
	< 1 teaspoon of salt	Reference	–	–
	≥ 1 teaspoon of salt	0.99	0.63–1.55	0.953
	Does not know	1.38	0.55–3.46	0.492
Individual level (1st level)	Any Comorbidity			
	No comorbidity	Reference	–	–
	Any comorbidity	1.04	0.65–1.67	0.876
Individual level (1st level)	Socioeconomic Status			
	Low	Reference	–	–
	Middle	0.96	0.56–1.65	0.881
	High	1.29	0.35–4.76	0.701
Individual level (1st level)	Severity of Illness			
	Mild	Reference	–	–
	Moderate	0.90	0.46–1.74	0.750
	Severe	1.31	0.73–2.35	0.375
Individual level (1st level)	Number of Medical Consultations			
	1–2 consultations	Reference	–	–
	3–4 consultations	0.75	0.44–1.28	0.294
	≥ 5 consultations	1.67	0.19–15.0	0.645
Individual level (1st level)	Other Medical Care			
	No	Reference	–	–
	Yes	5.09	2.98–8.70	< 0.001
Individual level (1st level)	Referrals (According to the patient)			
	No	Reference	–	–
	Yes	0.11	0.04–0.33	< 0.001
Health Center (2nd Level)	Type			
	UAPS	Reference	–	–
	CIS	0.85	0.23–3.21	0.814
Health Center (2nd Level)	Administration			
	Decentralized	Reference	–	–
	Centralized	0.90	0.23–3.48	0.877
Health Center (2nd Level)	Prevention and Promotion Activities			
	Low	N/A	N/A	N/A
	Moderate	Reference	–	–
	High	0.99	0.36–2.73	0.981
Health Center (2nd Level)	Technology Available Laboratory			
	Low	N/A	N/A	N/A
	Moderate	Reference	–	–
	High	0.58	0.17–2.00	0.392

Adjusted odds ratios were calculated using the same complete-case analytical sample (n = 486; 213 participants with controlled blood pressure and 273 with uncontrolled blood pressure).

Table 4. Multilevel logistic regression: Patient-level and health center-level variables (continued)

Level	Variable	Adjusted OR	95% CI	p-value
Health Center (2nd Level)	Technology Available Clinic			
	Low	Reference	–	–
	Moderate	0.54	0.11–2.55	0.437
	High	0.54	0.18–1.64	0.280

Adjusted odds ratios were calculated using the same complete-case analytical sample (n = 486; 213 participants with controlled blood pressure and 273 with uncontrolled blood pressure).

additional facilities, public or private, were more than five times more likely to achieve BP control (aOR = 5.09; $p < 0.001$). While all citizens theoretically have access to primary health care, this pattern suggests that relying on a single facility may present challenges for long-term management in resource-constrained settings. This association likely reflects proactive health care-seeking behavior to compensate for resource gaps at local clinics. However, this association should be interpreted cautiously, as patients who sought care at multiple facilities may also have had greater health awareness, better socioeconomic resources, or improved access to health services. Therefore, this association should not be interpreted as evidence that seeking care at multiple facilities directly improves BP control.

Socioeconomically disadvantaged patients in remote areas face barriers, such as transportation costs and travel times, that preclude them from seeking care from multiple providers. Consequently, vulnerable populations may remain dependent on a single facility. While access to primary care exists, it may not be sufficient to achieve BP control, a finding that is consistent with studies linking health care access disparities to BP outcomes (*20*).

Our findings deviate from the doctor-shopping phenomenon typical of high-income settings. While literature from the U.S., Taiwan, and France presents associations between multiple consultations and fragmented care and reduced continuity (*21*), the Honduran context is different. In a resource constrained health system, seeking other medical care likely represents an effort by patients to ensure treatment continuity and medication access, rather than a lack of coordination. These findings suggest that resource constraints and limited system coordination may encourage patients to seek care across multiple providers.

In Honduras, patients are referred to higher-complexity facilities precisely because they present with resistant hypertension or comorbidities (*14*). Therefore, referral status should not be interpreted as an independent factor associated with poor BP control but rather as a marker of greater clinical complexity at the time of referral. Association between referrals and uncontrolled BP reflects the fact that these patients were already at high-risk at enrollment. However, absence of documented counter referrals suggests a gap in the integrated care loop. Information on whether referrals were completed was not available in the medical records; therefore, the effectiveness of the referral process itself could not be evaluated. These findings highlight importance of strengthening referral and counter-referral coordination to reduce fragmented care and support consistent, stage-appropriate follow-up for high-risk patients within the health system.

We observed a clear association between insufficient BP control and high BMI, which conforms to evidence linking obesity to increased cardiovascular risk (*22*). This phenomenon is particularly concerning given the high prevalence of obesity in Honduras, which affects 30.3% of women and 18.3% of men (*23*). Consequently, these findings suggest the importance of weight management through expanded health screenings and early intervention strategies to prevent further clinical complications. Within primary healthcare, these strategies should be further strengthened through routine weight monitoring, dietary counseling, promotion of regular physical activity, and integrated cardiovascular risk management, particularly for patients with obesity and related comorbidities.

The trend toward better control among women observed in multilevel analysis ($p = 0.072$) agrees with the findings of studies in Jordan and Brazil. One possible explanation for this pattern is better treatment adherence, proactive health decision-making, and more robust social support networks, as suggested in previous studies (*24,25*). However, after accounting for clustering at the health-center level, this association was attenuated and no longer reached statistical significance. Physiological mechanisms, such as a more favorable anti-inflammatory immune response (*26*) and the cardioprotective effects of estrogen (*27*), may contribute to better BP control in women. One possible explanation, supported by previous literature, is that traditional gender roles in Honduras may limit healthcare attendance among some men. For example, work responsibilities among primary breadwinners may reduce opportunities to attend routine clinic visits without economic consequences.

Previous studies have suggested that sociocultural constructions, such as machismo, may be associated with health-seeking behaviors related to BP control. In many Latin American contexts, seeking care or admitting vulnerability can be stigmatized as a sign of weakness, thus discouraging men from addressing chronic conditions (*28*). While women seemingly exhibit better clinic attendance, they still face gender-based barriers such as economic dependence and restricted mobility. Although decision-making power was not significantly associated with BP control in this study, it remains a critical factor of health-seeking behavior in the region.

Patients attending 3–4 consultations during the previous six months had lower odds of BP control in the multivariable model; however, this association was no longer statistically significant in the multilevel model. This result deviates from findings of previous research, in which a positive correlation between the number of outpatient visits and successful BP control is typically revealed (*29*). It is possible that our results did not follow this trend in the final model because the sample size in specific groups, such as the group with ≥ 5 consultations, were very small.

Perceived disease severity indicated a notable trend toward significance in multivariable analysis, which may suggest that patients who view their condition as serious may be more likely to adhere to treatment and engage in proactive self-management. While our findings agree with those of studies in Iran and Vietnam linking risk perception to compliance (*30-32*), this association varies by social context. Furthermore, extreme perceived severity can be counterproductive, as heightened emotional stress and worry are linked to treatment nonadherence (*33,34*).

Unexpectedly, former smokers tended to achieve better hypertension control (p = 0.064). While smoking cessation stops further cardiovascular damage, its physiological benefits are often long-term (*35,36*). However, similar paradoxes in other studies suggest that compared with nonsmokers, successful quitters may develop an elevated sense of health consciousness and superior treatment adherence (*37,38*). Further research is needed to clarify behavioral mechanisms underlying this association.

No facility-level variables reached statistical significance in the multilevel model. However, these findings should be interpreted cautiously because only eight health centers were included, limiting the statistical power to detect facility-level associations. A possible explanation for the absence of significant facility-level associations is that all facilities followed comparable clinical procedures and national hypertension guidelines. The descriptive findings support this interpretation of relative homogeneity. Notably, most facilities demonstrated high performance in terms of prevention activities and reported moderate to high levels of diagnostic technology.

The strengths of this study include use of multilevel modeling to account for nested data and the reliance on medical records to reflect routine clinical practice. However, its cross-sectional design precludes causal inference. Limitations include potential documentation errors or missing behavioral data in physical records, and the small number of health centers, which limited the precision and statistical power to estimate facility-level associations. Some categories included a limited number of observations, which may have reduced the precision of the corresponding estimates; therefore, these results should be interpreted with caution. Specifically, estimates for the underweight BMI category, participants with ≥ 5 medical consultations, current smokers, and patients referred to higher levels of care may be less precise because of the small number of observations in these groups. Additionally, data on smoking duration and dietary patterns were unavailable. BP measurements were retrospectively obtained from routine clinical records. Although BP measurements were routinely performed by physicians and nurses following the National Hypertension Management Protocol of Honduras, adherence to standardized measurement procedures and consistency of BP devices across facilities could not be independently verified, which may have introduced measurement variability. Additionally, detailed information on antihypertensive treatment regimens, including number and classes of medications and treatment intensification, was not collected. These factors may also be associated with BP control and should be considered in future studies.

5. Conclusions

In this Honduran population, several patient-level factors were associated with hypertension control, whereas no statistically significant facility-level associations were detected in this sample. Because only eight health centers were included, the facility-level analysis should be considered exploratory. Referred patients and those with morbid obesity may represent particularly vulnerable subgroups, which highlights the need to reinforce implementation of existing metabolic management protocols at the primary level. Seeking other medical care was strongly associated with better BP control. This association may reflect proactive health-seeking behavior, greater health awareness, better access to additional health services, or ability to compensate for resource limitations within the primary care system. These findings suggest the importance of strengthening the capacity, continuity, and coordination of hypertension care within primary healthcare services to promote health equity and reduce patients' reliance on seeking care across multiple facilities. Improving the counter-referral system may further strengthen communication between different levels of care and support long-term clinical follow-up.

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