

Contribution Title

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Abstract. The abstract should summarize the contents of the paper in short terms, i.e. 150-250 words.

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1 Introduction

2 Materials and Methods

We used the database and questionnaires from the Encuesta Nacional de Salud y Nutrición Continua 2023 (ENSANUT 2023).

The main limitation of this study is that we only used the health questionnaire, which includes responses from individuals aged 20 years or older. Additionally, we focused exclusively on participants who answered “yes” to the question: “*Algún médico lee ha dicho que tiene le presión alta?*” (*Has any doctor told you that you have high blood pressure?*).

Therefore, the scope of this study is to observe the associations between health-related habits and hypertension-related complications in the Mexican population diagnosed with high blood pressure by a medical professional.

The database contains 6,722 records, of which 1,429 correspond to individuals who reported having hypertension, also, it has 758 variables. The analysis was conducted on these 1,429 records and limited to 17 variables selected based on their relevance to complications and hypertension-related habits. The selected variables are shown in Table 1.

Table 1. Selected variables

Mnemonic	Category	Question	Response	Response values
a0404	Treatments	Do you currently take any medicines (pills) to control your high blood pressure?	Yes, No.	1,2
a0401	Data	Has a doctor told you that you have high blood pressure?		1, 2, 3

			Yes, during pregnancy, No.	
a0405aa	Habit	In the last three months, have you stopped taking any of your blood pressure medications for at least 1 day?	Yes, No, Don't Know	1, 2, 9
A0408A	Treatments		Meal plan (diet recommended by health personnel)	1
A0408B	Treatments	What other treatment do you currently have to control your high blood pressure?	Do some physical exercise	2
A0408C	Treatments		Decrease in salt consumption	3
A0408D	Treatments		Alternative medicine	4
A0408E	Treatments		None	5
a0410a	Complication	Has hypertension caused retinal damage?	Yes, No.	1, 2
a0410b	Complication	Have you been on dialysis due to hypertension?	Yes, No.	1, 2
a0410c	Complication	Have you suffered a heart attack due to hypertension?	Yes, No.	1, 2
a0410d	Complication	Have you had a heart attack or stroke due to hypertension?	Yes, No.	1, 2
a0410e	Complication	Due to hypertension, have you gone to an emergency department in the last year?	Yes, No.	1, 2
a0410f	Complication	Have you been hospitalized for more than 24 hours in the past year because of hypertension?	Yes, No.	1, 2
a0502a	Complication	Has your doctor told you that you have (or had) a heart attack?	Yes, No.	1, 2
a0502c	Complication	Has your doctor told you that you have (or had) heart failure (weakened pumping ability of the heart, leading to edema in the feet, ankles, and legs, tiredness, and shortness of breath)?	Yes, No.	1, 2

a0502d	Complica- tion	Has your doctor told you that you have (or had) a stroke or Yes, No. stroke?	1, 2
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2.1 Data Preprocessing

The dataset was cleaned by removing unselected variables and excluding records where a0401 indicated no hypertension. Fortunately, the registers on the variable a0401 didn't present any empty value, that's why we only had to check if the values on the register were 1 or 2.

For missing values in the selected variables, missing entries were imputed as 0, if a lack of response indicated absence of the habit or complication. The categorical variables were coded as binary variables to facilitate logistic regression and calculate conditional probabilities consistently. For dichotomous response variables (Yes/No), the values were coded as 1, while responses of "No" or "Don't know" were coded as 0. The variables corresponding to treatments were coded in the next form, considering that the codes could appear in different columns:

- A0408A: 1 if A0408A is 1
- A0408B: 1 if A0408A is 2 or if A0408B is 2
- A0408C: 1 if A0408A is 3 or if A0408B is 3 or if A0408C is 3
- A0408D: 1 if A0408A is 4 or if A0408B is 4 or if A0408C is 4 or if A0408D is 4
- A0408E: 1 if A0408A is 5

For the variable a0401 we assigned the value 1 if the response was 1 or 2 (Yes/Yes, during pregnancy).

2.2 Statistical analysis

To analyze the data, we used three strategies:

Univariate analysis. For each variable, we made a simple association analysis using 2x2 contingency tables between each binarized habit and the presence of the complication. Based on these tables, crude odds ratios, p-values (Fisher's exact test), and rates for each group were calculated.

Multivariate logistic regression models. A logistic regression model was fitted, simultaneously considering all selected habits as independent variables and each complication as a dependent variable. Thanks to this process, log-odds coefficients were obtained and adjusted odds ratios ($\exp(\text{coefficient})$).

Adjusted Probabilities Estimation. From the multivariate logistic regression model, adjusted probabilities were calculated using counterfactual simulations. For each habit, the other variables were set to their median value. The estimated probabilities of developing the complication were compared with the habit present (1) and absent (0). Finally, we add the difference in probability attributable to each habit.

2.3 Software

All analyses were performed using Python (version 3.12.2), with the library's pandas, numpy, sklearn, and scipy.

3 Results

3.1 Variable a0410a

Table 2. Univariate analysis a0410a

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	2.19076087	0.00010626	0.180765806	0.091503268	18.07658059	9.150326797
a0405aa	1.899948427	4.58E-05	0.232686981	0.137640449	23.26869806	13.76404494
A0408A	1.479593792	0.012060014	0.202597403	0.146551724	20.25974026	14.65517241
A0408B	1.043877551	0.839263595	0.166666667	0.160787531	16.66666667	16.07875308
A0408C	1.466323024	0.035650542	0.208163265	0.152027027	20.81632653	15.2027027
A0408D	0.800694444	0.703477052	0.134615385	0.162672476	13.46153846	16.26724764
A0408E	0.637976023	0.00222617	0.135365854	0.197044335	13.53658537	19.7044335

Table 3. Multivariate logistic regression models a0410a

Variable	Log odds	Odds ratio
a0405aa	0.229871002	1.258437663
a0404	0.117376025	1.124542206
A0408E	-0.265944987	0.766481293
A0408A	-0.0639088	0.938090549
A0408C	0.042172213	1.043074094
A0408D	-0.088331782	0.915457094
A0408B	-0.115012027	0.891355423

Table 4. Adjusted Probabilities Estimation a0410a

Habit	P event if habit_0	P event if habit_1	Probability difference
a0405aa	0.451320122	0.508632323	0.057312201
a0404	0.422452347	0.451320122	0.028867775
A0408E	0.517644347	0.451320122	-0.066324226
A0408A	0.451320122	0.435548802	-0.01577132
A0408C	0.451320122	0.461783168	0.010463046
A0408D	0.451320122	0.429554242	-0.02176588
A0408B	0.451320122	0.423029235	-0.028290887

3.2 Variable a0410b

Table 5. Univariate analysis a0410b

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	1.36732852	0.77810306	0.013357079	0.009803922	1.335707925	0.980392157
a0405aa	0.843537415	1	0.011080332	0.013108614	1.108033241	1.310861423
A0408A	0.77240345	0.79322535	0.01038961	0.013409962	1.038961039	1.340996169
A0408B	1.163285024	0.739209805	0.014285714	0.012305168	1.428571429	1.230516817
A0408C	0.600823045	0.753642805	0.008163265	0.013513514	0.816326531	1.351351351
A0408D	1.568627451	0.488953864	0.019230769	0.012345679	1.923076923	1.234567901
A0408E	1.16934487	0.814532278	0.013414634	0.011494253	1.341463415	1.149425287

Table 6. Multivariate logistic regression models a0410b

Variable	Log odds	Odds ratio
A0408C	-0.646278926	0.523991967
a0404	0.220407677	1.246584831
A0408A	-0.420513918	0.656709238
A0408D	-1.04536212	0.351564488
A0408E	-0.496609767	0.60859043
a0405aa	0.035214315	1.035841682
A0408B	-0.188084659	0.828544561

Table 7. Adjusted Probabilities Estimation a0410b

Habit	P event if habit_0	P event if habit_1	Probability difference
A0408C	0.366279923	0.232457149	-0.133822774
a0404	0.316778319	0.366279923	0.049501604
A0408A	0.366279923	0.275135029	-0.091144894
A0408D	0.366279923	0.168881991	-0.197397932
A0408E	0.487102933	0.366279923	-0.12082301
a0405aa	0.366279923	0.374491652	0.008211729
A0408B	0.366279923	0.323815044	-0.042464878

3.3 Variable a0410c

Table 8. Univariate analysis a0410c

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
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a0404	9.811580882	0.003127728	0.031166518	0.003267974	3.116651825	0.326797386
a0405aa	2.161436829	0.030921742	0.041551247	0.019662921	4.155124654	1.966292135
A0408A	0.901595745	1	0.023376623	0.025862069	2.337662338	2.586206897
A0408B	0.72026699	0.810521525	0.019047619	0.026251025	1.904761905	2.625102543
A0408C	1.895253682	0.112585135	0.040816327	0.021959459	4.081632653	2.195945946
A0408D	0	0.638872822	0	0.026143791	0	2.614379085
A0408E	0.9265625	0.865316796	0.024390244	0.026272578	2.43902439	2.6272578

Table 9. Multivariate logistic regression models a0410c

Variable	Log odds	Odds ratio
a0404	0.713439534	2.040999286
a0405aa	0.243016432	1.275089577
A0408C	0.42649189	1.531874103
A0408D	-0.852216908	0.426468442
A0408B	-0.033007701	0.967531109
A0408A	-0.167835906	0.845492563
A0408E	0.135370841	1.144961304

Table 10. Adjusted Probabilities Estimation a0410c

Habit	P event if habit_0	P event if habit_1	Probability difference
a0404	0.419795445	0.596240901	0.176445455
a0405aa	0.596240901	0.653133779	0.056892879
A0408C	0.596240901	0.693454251	0.09721335
A0408D	0.596240901	0.386418875	-0.209822026
A0408B	0.596240901	0.588270106	-0.007970795
A0408A	0.596240901	0.555270825	-0.040970076
A0408E	0.563272853	0.596240901	0.032968048

3.4 Variable a0410e

Table 11. Univariate analysis a0410e

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	1.620739978	0.19182111	0.056990205	0.035947712	5.699020481	3.594771242
a0405aa	1.514880952	0.102470849	0.069252078	0.046816479	6.925207756	4.68164794
A0408A	1.057692308	0.893654256	0.054545455	0.051724138	5.454545455	5.172413793
A0408B	1.355971897	0.315301539	0.066666667	0.050041017	6.666666667	5.004101723
A0408C	1.332247798	0.344066982	0.065306122	0.049831081	6.530612245	4.983108108
A0408D	1.109693878	0.750988196	0.057692308	0.052287582	5.769230769	5.22875817
A0408E	0.710055791	0.151887633	0.045121951	0.062397373	4.512195122	6.239737274

Table 12. Multivariate logistic regression models a0410e

Variable	Log odds	Odds ratio
a0405aa	0.086832676	1.090714162
a0404	0.110525721	1.116865076
A0408E	-0.444435602	0.641186058
A0408B	-0.053170069	0.948218737
A0408C	-0.055631718	0.945887425
A0408A	-0.302165102	0.739216009
A0408D	-0.059830649	0.941924036

Table 13. Adjusted Probabilities Estimation a0410e

Habit	P event if habit_0	P event if habit_1	Probability difference
a0405aa	0.406991502	0.428105775	0.021114274
a0404	0.380614184	0.406991502	0.026377318
A0408E	0.516998241	0.406991502	-0.110006739
A0408B	0.406991502	0.394225077	-0.012766424
A0408C	0.406991502	0.39363736	-0.013354142
A0408A	0.406991502	0.336577964	-0.070413537
A0408D	0.406991502	0.392635579	-0.014355923

3.5 Variable a0410f

Table 14. Univariate analysis a0410f

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	2.716328413	0.057427378	0.034728406	0.013071895	3.472840606	1.307189542
a0405aa	2.416666667	0.006645869	0.052631579	0.02247191	5.263157895	2.247191011
A0408A	1.999128065	0.034789906	0.046753247	0.02394636	4.675324675	2.394636015
A0408B	1.339745403	0.509200673	0.038095238	0.028712059	3.80952381	2.871205906
A0408C	1.915547556	0.06479898	0.048979592	0.026182432	4.897959184	2.618243243
A0408D	2.046428571	0.203544799	0.057692308	0.029048656	5.769230769	2.90486565
A0408E	0.347394541	0.001433686	0.017073171	0.047619048	1.707317073	4.761904762

Table 15. Multivariate logistic regression models a0410f

Variable	Log odds	Odds ratio
A0408E	-0.643391288	0.525507252
a0405aa	0.215788211	1.240839555
A0408A	-0.006985126	0.993039213
a0404	0.321281714	1.37889398
A0408C	0.062347567	1.064332207

A0408D	0.143620554	1.154445976
A0408B	-0.242862815	0.784379112

Table 16. Adjusted Probabilities Estimation a0410f

Habit	P event if habit 0	P event if habit 1	Probability difference
A0408E	0.504836485	0.348862098	-0.155974388
a0405aa	0.348862098	0.399330246	0.050468148
A0408A	0.348862098	0.347277055	-0.001585043
a0404	0.27982568	0.348862098	0.069036418
A0408C	0.348862098	0.363154857	0.014292759
A0408D	0.348862098	0.382151964	0.033289867
A0408B	0.348862098	0.295898182	-0.052963916

3.6 Variable a0502a

Table 17. Univariate analysis a0502a

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	1.928369463	0.074368455	0.055209261	0.029411765	5.520926091	2.941176471
a0405aa	1.349587623	0.26327098	0.060941828	0.04588015	6.094182825	4.588014981
A0408A	1.146923077	0.585746782	0.054545455	0.04789272	5.454545455	4.789272031
A0408B	0.622306034	0.302172379	0.033333333	0.052502051	3.333333333	5.250205086
A0408C	1.560266407	0.143961791	0.069387755	0.045608108	6.93877551	4.560810811
A0408D	0.366106443	0.513207583	0.019230769	0.050835149	1.923076923	5.083514887
A0408E	0.848174843	0.538983859	0.046341463	0.054187192	4.634146341	5.418719212

Table 18. Multivariate logistic regression models a0502a

Variable	Log odds	Odds ratio
a0404	0.358929567	1.431795952
A0408C	0.221315005	1.247716406
A0408B	-0.19880454	0.819710098
a0405aa	0.005779723	1.005796458
A0408D	-0.132078243	0.87627243
A0408E	-0.118835108	0.887954205
A0408A	-0.130847225	0.877351802

Table 19. Adjusted Probabilities Estimation a0502a

Habit	P event if habit 0	P event if habit 1	Probability difference
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a0404	0.443257511	0.532697679	0.089440168
A0408C	0.532697679	0.587173429	0.05447575
A0408B	0.532697679	0.483049773	-0.049647906
a0405aa	0.532697679	0.534136155	0.001438476
A0408D	0.532697679	0.49972485	-0.03297283
A0408E	0.562130412	0.532697679	-0.029432732
A0408B	0.451320122	0.423029235	-0.028290887

3.7 Variable a0502c

Table 20. Univariate analysis a0502c

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	2.496028006	0.016157989	0.055209261	0.022875817	5.520926091	2.287581699
a0405aa	1.219701957	0.478378017	0.055401662	0.04588015	5.540166205	4.588014981
A0408A	1.475900277	0.163222822	0.062337662	0.043103448	6.233766234	4.310344828
A0408B	0.983050847	1	0.047619048	0.048400328	4.761904762	4.840032814
A0408C	1.906725664	0.031481045	0.07755102	0.04222973	7.755102041	4.222972973
A0408D	1.682051282	0.312526551	0.076923077	0.047204067	7.692307692	4.720406681
A0408E	0.555014606	0.017924273	0.036585366	0.064039409	3.658536585	6.403940887

Table 21. Multivariate logistic regression models a0502c

Variable	Log odds	Odds ratio
A0408E	-0.013029385	0.98705513
A0408C	0.25628333	1.292118772
a0404	0.808712664	2.245016035
A0408A	0.091862792	1.096214402
A0408D	0.342715762	1.408768279
a0405aa	-0.035014014	0.965591884
A0408B	-0.262972653	0.76876292

Table 22. Adjusted Probabilities Estimation a0502c

Habit	P event if habit 0	P event if habit 1	Probability difference
A0408E	0.635456284	0.632432712	-0.003023571
A0408C	0.632432712	0.689749995	0.057317282
a0404	0.433878242	0.632432712	0.198554471
A0408A	0.632432712	0.653515966	0.021083254
A0408D	0.632432712	0.707936508	0.075503796
a0405aa	0.632432712	0.62425622	-0.008176492
A0408B	0.632432712	0.569471394	-0.062961319

3.8 Variable a0502d

Table 23. Univariate analysis a0502d

Variable	Odds ratio	P value	Prob event if 1	Prob event if 0	Rate 1	Rate 0
a0404	1.147186933	1	0.018699911	0.016339869	1.869991095	1.633986928
a0405aa	1.580715241	0.261108594	0.024930748	0.015917603	2.493074792	1.5917603
A0408A	1.713333333	0.185187745	0.025974026	0.01532567	2.597402597	1.53256705
A0408B	0.478766026	0.410982999	0.00952381	0.019688269	0.952380952	1.968826907
A0408C	1.461087866	0.429219217	0.024489796	0.016891892	2.448979592	1.689189189
A0408D	1.060392157	1	0.019230769	0.01815541	1.923076923	1.815541031
A0408E	0.738537794	0.549028316	0.015853659	0.02134647	1.585365854	2.134646962

Table 24. Multivariate logistic regression models a0502d

Variable	Log odds	Odds ratio
A0408A	0.358202753	1.430755681
a0405aa	0.127604395	1.136103466
A0408B	-0.267964346	0.764935054
A0408C	0.254009912	1.289184583
A0408E	0.218463791	1.244163966
a0404	0.129950639	1.138772171
A0408D	-0.863521468	0.421674551

Table 25. Adjusted Probabilities Estimation a0502d

Habit	P event if habit 0	P event if habit 1	Probability difference
A0408A	0.526418168	0.613956477	0.087538309
a0405aa	0.526418168	0.558080522	0.031662354
A0408B	0.526418168	0.459540364	-0.066877804
A0408C	0.526418168	0.58898744	0.062569272
A0408E	0.471856623	0.526418168	0.054561545
a0404	0.493955428	0.526418168	0.03246274
A0408D	0.526418168	0.3191349	-0.207283268

4 Discussion

5 Conclusions

6 Conflict Statement (IA disclosure)

7 References

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