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| RESEARCH ARTICLE

Analysis of the Explanatory Factors of Hypertension in People Aged 30 to 64 in Benin

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| ABSTRACT
In Benin, hypertension is a leading cause of death and a significant contributor to the disease burden. This study aims to determine the explanatory factors of high blood pressure among people aged 30 to 64 years in Benin. We used data from Benin's 2017-2018 Demographic Health Survey to analyse hypertension determinants. Based on the Akaike Information Criterion (AIC) score, the Probit model (5922.56) is a better fit for the data than the Logit model (5924.997). The probit estimate indicates that the likelihood of having high blood pressure increases, with odds ratios ranging from 1.1453 for the age group of 35-39 years to 1.9572 for the age group of 50-54. Being female, living in the South or Centre region, having higher education levels, and having diabetes also increase the likelihood of having high blood pressure. These findings provide insight into the factors that contribute to the prevalence of high blood pressure and may help inform public health interventions aimed at reducing its incidence.

| KEYWORDS

Determinants, Hypertension, Benin, Cardiovascular diseases, Econometrics, Health Economics

| ARTICLE INFORMATION

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1. Introduction

Cardiovascular disease is a significant and growing public health problem worldwide, a trend that is occurring at an alarming rate in low- and middle-income countries (LMICs), with a rapidly increasing disease burden. According to the Medical Research Foundation (MRF), these diseases include pathologies that affect the heart and all blood vessels, such as atherosclerosis, heart rhythm disorders, myocardial infarction, heart failure, strokes and high blood pressure, which is the subject of this paper. According to the World Health Organisation (WHO), arterial hypertension (AH) and clinical hypertension are major risk factors for cardiovascular disease and chronic kidney disease and a significant cause of mortality worldwide.

Between 2000 and 2010, the proportion of the world's population with high blood pressure or uncontrolled hypertension decreased slightly by 2.6% in high-income countries (Mills et al., 2016). However, significant increases due to population growth and ageing have been recorded by the World Health Organization (WHO) over the past decade, with the most significant increase being 30% in Africa. The lowest prevalence of high blood pressure was noted in the Americas region, at 18%, while the global estimate among adults aged 18 years and older was about 22% in 2014 (Khot et al., 2003). This indicates that African regions are affected in a very worrying proportion.

Despite the availability of low-cost antihypertensive drugs in Benin, data suggest that less than half of hypertensive people have been treated, and less than one-third received appropriate management. Despite the reforms put in place to fight against NCDs, notably through the installation of the National Programmes for the Fight against NCDs (PNLMNT) and the National Health

Information and Management System (SNIGS), hypertension is a disease that remains and persists. Hypertension affects 25.9% of Beninese adults according to a national survey conducted in 2015 by the Ministry of Health, using the World Health Organization's stepwise methodology; about 68.2% had never had their blood pressure (BP) measured, and more than half of those with high BP were unaware of their status (World Health Organization, 2015). All these facts show that late diagnosis of hypertension and poor BP control increase the frequency of hypertensive complications.

Globally, cardiovascular disease (CVD) is considered the leading cause of death or disability-adjusted life years, with hypertension playing a central role in CVD (Forouzanfar et al., 2017). High blood pressure accounts for about 13.5% of annual deaths worldwide. In 2016, about 17.9 million people died from CVD, accounting for 31% of all deaths worldwide, of which 9.4 million were attributed to hypertension (World Health Organization, 2018). Worldwide, about 1.13 billion people have high blood pressure, and two-thirds live in low- and middle-income countries (World Health Organization, 2018).

According to (WHO, 2022), NCDs are increasingly becoming the leading cause of death in sub-Saharan Africa. Indeed, in Africa, between 50% and 88% of deaths are due to NCDs, while in 2019, NCDs accounted for 37% of mortality. In Africa, the focus is on infectious and communicable diseases, to the detriment of high blood pressure, which is poorly understood or treated and is a silent killer. (Dauphinot et al., 2008). The African Region has the highest prevalence of hypertension, affecting 46% of adults aged 25 years and over. Overall, high-income countries have a lower prevalence of hypertension (35%) than other country groups (40%) (World Health Organization, 2011). Almost 80% of deaths from cardiovascular disease occur in low- and middle-income countries. These countries can least afford the social and economic consequences of ill health. Age-standardised mortality rates are higher in low-income and developed countries (World Health Organization, 2011).

In Benin, according to a study conducted on the management of hypertension in the city of Cotonou in 2011, it was shown that 4.8% of general practitioners did not know the definition of hypertension, and only 61% could describe the conditions for measuring blood pressure (Houenassi et al., 2016).

High blood pressure is a driver of household poverty. Premature death, disability, personal and family disruption, loss of income and health care costs associated with high blood pressure place a heavy burden on families, communities and public finances. In low- and middle-income countries, many people do not seek treatment for hypertension because it is too expensive. Families are then faced with exorbitant health care costs, often in the long term, for complications of hypertension, which pushes millions of people into poverty (World Health Organization, 2011). In Benin, at the end of the 2007 STEP survey, the prevalence of hypertension was 27.5% and fell to 25.9% in 2015, a drop of 1.7 percentage points in 8 years. There has undoubtedly been some decline, but not by a significant amount. This shows the persistence of hypertension despite all the measures put in place.

It should be noted that hypertension significantly affects the production of countries in the sense that it contributes to a decline in the latter. According to the WHO, the GDP of poor countries falls by 4% each year due to primary non-communicable diseases, with cardiovascular diseases, especially hypertension, accounting for almost half of this cost (World Health Organization, 2013). Indeed, this impact on the production of poor countries could be attributed to a reduced labour force due to the number of deaths and recurrent cases of paralysis attributable to hypertension. In addition to the economic impact discussed above, it should be noted that the continued and even increasing prevalence of non-communicable diseases will result in significant public expenditure on health for these countries.

It is, therefore, necessary to examine the factors that explain hypertension in Benin. To do this, it is necessary to answer the following question: What factors explain high blood pressure in Benin individuals aged 30 to 64? The interest of this paper is that once these factors are identified, they can be used to inform patients about their disease and enable them to make appropriate arrangements at an early stage.

This article is organised into three parts. The first part presents the literature review and formulation of the research hypotheses. The second part deals with methodological aspects. The third part is devoted to the analysis of empirical results and discussions.

2. Literature review and formulation of research hypotheses

2.1 Definitions of concepts

Hypertension: High blood pressure (HBP) is an abnormal increase in blood pressure in the artery walls. According to the WHO, a person is considered to have high blood pressure when a systolic blood pressure of 140 mm Hg or more and a diastolic blood pressure of 90 mm Hg or more are repeatedly recorded and not on the same day.

Systolic blood pressure: Systolic pressure is the blood pressure measured during the systole phase, i.e. the maximum blood pressure at the peak of the systolic ejection phase (Abbou & El Akhrif, 2016). Diastolic blood pressure: Diastolic pressure is the blood pressure measured during the relaxation phase of the heart, i.e. the minimum blood pressure before the aortic valves open (Abbou & El Akhrif, 2016). According to (World Health Organization, 2013), a Risk factor: is "any attribute, characteristic or exposure of a subject that increases the likelihood of developing a disease or suffering an injury".

2.2 Theoretical review

According to the WHO, high blood pressure (HBP) is a major global public health problem, and its prevalence varies considerably from one context to another. In 2008, according to WHO, the global prevalence of hypertension among adults aged 25 years and over was about 40%, the highest in the African Region (46%). (World Health Organization, 2013) groups the explanatory factors of high blood pressure into three main ones: social, behavioural and metabolic. To begin with, among the social factors, emphasis is placed on urbanisation, ageing, income, education and housing. Among the behavioural factors, the following are recorded: poor diet, smoking, lack of physical activity, sedentary lifestyle and harmful use of alcohol. Finally, the metabolic factors identified are obesity, diabetes and hyperlipidaemia (World Health Organization, 2013).

In Algeria, a study conducted in Tlemcen on the risk factors for cardiovascular disease in a sample of 1,300 people showed that 36.2% [95% CI: 32.2-40.4] of people were hypertensive (Yahia-Berrouiguet et al., 2011). This prevalence was found to be higher in men than in women and increased with age. However, it was noted that among people with high blood pressure, only 35% knew they were hypertensive, and this knowledge was significantly higher in the female sub-population than in the male sub-population. (Lang et al., 1983) in a study of 1491 people, the association between smoking and coffee consumption and high blood pressure was demonstrated. Through a multivariate analysis incorporating variables such as gender, age, BMI, exercise, residence, smoking and coffee consumption, they found that smoking and coffee consumption significantly promoted blood pressure.

In 2007 in France, the Mona Lisa study (Wagner et al., 2008) study in France in 2007, which included 4825 people, also showed that compared to women, men had a higher prevalence of hypertension (47% compared to 35%) and that this prevalence increased with age. However, women had more controlled medical follow-ups than men (39% versus 24%), but this decreased as they aged. On the other hand, (Frérot et al., 1999), in a study conducted in France on 14492 people aged 20 years or more, hypertension was 16.5%, with a prevalence of 18.8% for women and 14% for men. This indicates that women are more affected by hypertension than men. Several factors are determinants of hypertension, according to the study conducted by (Frérot et al., 1999), in which particular emphasis was placed on socio-economic factors. Variables such as education level, current occupation, household income, geographical area (regions), household size, BMI, smoking status, education, social background, and interaction between age and retirement variables were related to the prevalence of hypertension. Two logistic regression models were estimated: one for men and one for women. Overall, in both models, age, income and BMI significantly affected the prevalence of hypertension. Specifically, education and occupation had a significant effect on the prevalence of hypertension in men, while in women, geographical area and household size significantly affected hypertension. In this study by (Frérot et al., 1999), it was found that smoking, social background and education do not determine high blood pressure as many studies have argued.

In 2008, in the French West Indies, the prevalence of arterial hypertension (AH) was 19% among employees, with a progression of this frequency with age (Inamo, 2008). It has been found that being overweight and sedentary increases the probability of being hypertensive. Also, certain factors such as gender, smoking and socioeconomic factors (education level, socio-professional categories and standard of living) significantly impact the prevalence of hypertension. In addition, psychosocial factors also play a role in developing hypertension, including a lack of confidence in the future. The INTERHEART study has shown the importance of psychosocial factors in the prevalence of cardiovascular disease. Indeed, psychosocial determinants significantly affected and increased the probability of the occurrence of myocardial infarction, and the share of the risk attributable to hypertension was 19.7% (Rosengren et al., 2004). (Cooper, 2001) highlighted the role of urbanisation in raising blood pressure through synthesising the literature on hypertension in sub-Saharan Africa. It also showed a significant positive association between obesity and systolic and diastolic blood pressure. Furthermore, obesity was associated with the risk of hypertension.

A study conducted in Morocco on 525 people with type 24 diabetes (Berraho et al., 2009) found a prevalence of hypertension of 70.4%, 67.7% in men and 72.0% in women. Variables such as age, education level, body mass index, physical activity, duration of diabetes and smoking status were related to hypertension (HTA) in these subjects, and logistic regression confirmed the positive effect of age, body mass index (BMI), duration of diabetes in females and only age in men.

A study in Congo among adults (Katchunga et al., 2011) showed the influence of age, overweight and diabetes mellitus on hypertension. Also, in Congo, in a study conducted among the military, 53.5% of those surveyed were hypertensive (Ngombe et al., 2015). However, the factors that were linked to hypertension in this study were age, BMI, abdominal obesity and alcohol consumption. Multivariate analysis revealed age, alcohol consumption and BMI as risk factors, thus agreeing with the previous study. The Dakar study by (Macia et al., 2015) provided information on some factors influencing the risk of hypertension. These analyses indicated that education level, marital status, obesity and age were associated with hypertension. However, the factors significantly affecting hypertension in the logistic model were age and BMI. The risk of being hypertensive increases with age. The same is true when moving from an average-weight individual to an overweight individual.

In Benin, a study conducted in the departments of Borgou and Alibori in a population aged 15 to 72 years showed a prevalence of 31.1% (Séraphin et al., 2016). In their study conducted in the departments of Borgou and Alibori, they identified obesity, excessive consumption of herbal tea, smoking, proteinuria and haematuria as risk factors for AH. In this study, contrary to other studies, age, alcohol consumption and variables concerning diet quality were not determinants in the occurrence of hypertension.

The following assumptions can be made from the above :

Hypothesis 1: Socio-demographic, economic and metabolic factors are the factors that influence the prevalence of hypertension.
Hypothesis 2: Women of advanced age, married, wealthy and diabetic are most likely to have hypertension.
Hypothesis 3: People suffering from hypertension constitute a heterogeneous group by gender.

3. Methodology

3.1 Study Design and study population

This study followed a cross-sectional study design based on an analysis of secondary data from the 2017-2018 Demographic Health Survey (EDSB-V) conducted by INStaD. Indeed, the EDSB-V is a survey within the framework of the DHS programme providing data on indicators relating to child health, maternal health, fertility, communicable and non-communicable diseases, consumption habits, malaria, etc. More explicitly, we use the Women's file (BJIR71SV) and the Men's file (BJMR71SV).

Data collection was conducted among women aged between 30 and 49 years for women and among men aged between 30 and 64 years. During the EDSB-V, blood pressure was only measured in these individuals. The sample considered in the EDSB-V is a representative sample at both the departmental and national levels, based on the two-stage stratified sampling method. The country is subdivided into 12 study areas that can be assimilated into the twelve departments, and the stratification at the departmental level takes into account the nature of the area, notably rural or urban.

The primary units represent the enumeration areas set up during the third General Census of Population and Housing conducted in Benin (RGPH3). The secondary units represent households. Thus, 555 enumeration zones were drawn at the first stage by the systematic sampling method with a probability equivalent to the size of the zone. In the second stage, 26 households were drawn in each enumeration area selected in the first stage, taking into account whether it was in a rural or urban area, using the systematic sampling method with equal probability.

3.2 Data analysis

A logit model and a probit model were estimated, and the Akaike information criterion (AIC) was computed for each model to determine the optimal model for the study. The AIC results indicate that the probit model is a better fit for the data than the logit model. Probit regression analysis was performed to identify factors that influence the prevalence of high blood pressure, and the model coefficients, odds ratios, and p-values were calculated for each variable included in the analysis. Additionally, various statistical tests were employed to assess the relevance and quality of the model.

4. Analysis of empirical results and discussion

4.1 Analysis of empirical results: Econometric analysis

4.1.1 Estimation of the common model - Choice of model

We estimated a logit model and a probit model and then calculated the AIC criterion for each of these models in order to choose the best model for our study.

Model A : logit (hypertension~age + gender + residence + region + education + occupation + marital status + standard of living + diabetes)
Model B: probit (hypertension~age + gender + residence + region + education + Occupation + marital status + standard of living + diabetes)

Table 1: Model choice test results

	AIC
Model A	5924,997
Model B	5922,56

Source: Authors, 2023

Comparing the AIC of each model, we notice that model B has the lowest AIC (5922.56). Thus, we will estimate a probit model.

4.1.2 Choice of explanatory variables

As announced in the methodology, we performed two estimations to give the best possible prediction of the explanatory factors of hypertension in our population. Model 1 consists of all explanatory variables related to our variable of interest from the Chi-square test; model 2 is obtained from stepwise regression.

Model 1: hypertension~age + gender + residence + region + education + marital status + occupation + living standard + diabetes

Model 2: hypertension~age + gender + residence + region + education + marital status + living standard + diabetes

Table 2: Results of the tests for the choice of the best combination of variable

	Resid. Dev	AIC
Model 1	5872,6	5922,56
Model 2	5873,8	5921,822

Source: Authors, 2023

Comparing the AIC of each model, we notice that model 2 has the lowest AIC (5921.822). Thus, the best model retained for the prediction of our variable of interest is model 2.

4.1.3 Probit regression results

Table 3: Probit estimation results

Variables	**Coefficients**	**Odds Ratio**	***p-value***
Age (reference = 30-34 years)			
35-39 years	0,1357	1,1453	0,01277*
40-44 years	0,3246	1,3834	2,285e-08***
45-49 years	0,4076	1,5033	2,608e-12***
50-54 years	0,6715	1,9572	7,577e-15***
55-59 years	0,6545	1,9242	1,039e-11***
60-64 years	0,5935	1,8104	1,765e-07***
Gender (reference = male)			
Female	0,2967	1,3454	5,372e-12***
Place of residence (reference = Urban)			
Rural	-0,0676	0,9346	0,11986
Region (reference = North)			
South	0,3394	1,4041	1,768e-10***
Centre	0,4488	1,5665	< 2,2e-16***
Instruction (reference = No instruction)			
Primary	-0,0019	0,9980	0,9687
Secondary	0,1483	1,1599	0,0117*
Superior	-0,1826	0,8330	0,0838.
Marital status (reference = Never in union)			
Married	0,0438	1,0448	0,7341

Life with a partner	0,2391	1,2701	0,0741.
Widower	0,1832	1,2010	0,2706
Divorced	0,2562	1,2921	0,2000
Separate	0,1259	1,1342	0,4317
Standard of living (reference = very poor)			
Poor	0,1411	1,1515	0,0312*
Medium	0,1620	1,1758	0,0151*
Rich	0,3488	1,4173	1,025e-07***
Very rich	0,4442	1,5593	8,378e-10***
Diabetes (reference = No)			
Yes	0,7160	2,0464	1,430e-07***

Source: Authors, 2023
(ns) Not significant ; (.) 10% ; (*) 5% ; (**) 1% ; (***) 0.1%.

The table shows that the coefficients of the modalities "female gender", "southern region", "central region", "secondary education", "poor standard of living", "average standard of living", "rich standard of living", "very rich standard of living", "diabetes yes" and all the modalities of the age variable are significant at the 5% threshold and positively related to the probability of having hypertension.

4.1.4 Relevance of the model

Table 4: Relevance of the probit model

Tests	**(1) Significance criterion**
Rule of thumb	D/v = 0.8699
Hosmer-Lemeshow test	Pr (Chi2) = 0.433
Pearsonresidualtest	Pr (Chi2) =0.5483
Residual test of deviance	Pr (Chi2) ~= 1

Source: Authors, 2023

It can be seen that the D/v value is very close to 1. Moreover, the Chi-square probabilities of the Hosmer-Lemeshow tests, the Pearson residuals and the deviance residuals are all above the 5% threshold, so the model fits the data well. Thus, the model is relevant.

4.1.5 Quality of the model

Table 5: Model quality

Tests	Values
Error rate	0.1779
The area under the ROC curve	0.6944

Source: Authors, 2023

The error rate of the model is less than 0.5, so the model is of good quality. In addition, the area under the ROC curve (0.90) is greater than 0.60, so the model has good predictive quality.

4.1.6 Marginal effects

Table 6: Marginal effects

Variables	**MEA (%)**
Age (reference = 30-34 years)	
35-39 years	2.78
40-44 years	7.29

45-49 years	9.51
50-54 years	17.44
55-59 years	16.89
60-64 years old	14.96
Gender (reference = male)	
Female	7.2
Place of residence (reference = Urban)	
Rural	-1.63
Region (reference = North)	
South	7.61
Centre	10.58
Instruction (reference = No instruction)	
Primary	-0.05
Secondary	3.76
Superior	-4.01
Marital status (reference = Never in union)	
Married	1
Life with a partner	5.94
Widower	4.44
Divorced	6.41
Separate	2.98
Standard of living (reference = very poor)	
Poor	2.94
Medium	3.41
Rich	8.03
Very rich	10.68
Diabetes (reference = No)	
Yes	21.85

Source: Authors, 2023

(ns) Not significant ; (.) 10% ; (*) 5% ; (**) 1% ; (***) 0.1%

From the table, the probability of an individual having hypertension increases by 2.78% when aged 35-39; it increases by 7.29% when aged 40-44 and by 9.51% when aged 45-49. For those aged 50 to 54, it increases by 17.44% and by 16.89% for those aged 55 to 59. For individuals aged 60 to 64, the probability that they are hypertensive increases by 14.96%. It should be noted that advanced age increases the probability of having hypertension. Also, the probability of being hypertensive increases by 21.85% when the individual has diabetes. The probability that an individual has hypertension increases by 7.20% when they are female. Again, the probability of an individual having hypertension increases by 3.76% when they have a secondary education and decreases by 4% when they have a tertiary education. This could be due to the fact that people with higher education are more informed about hypertension and therefore take precautions to avoid it. The probability of an individual having hypertension increases by 2.94% when they have a poor standard of living and by 8.03% when they have a rich standard of living. On the other hand, it increases by 3.41% when the individual has an average standard of living and by 10.68% when he or she has a very rich standard of living. Furthermore, it can be seen that the higher the individual's standard of living, the higher the probability of having hypertension. The probability of an individual having AH increases by 7.61% when living in the south of Benin and by 10.58% when living in the centre of Benin.

4.2 *Interpretation of results*

The prevalence of hypertension in our population (17.9%) is almost similar to that found in Côte d'Ivoire by (Sackou et al., 2019), which was 18.3%.
According to the estimation results in Table 3.5, we note that:

People in the 35-39 age group are 1.14 times more likely to have high blood pressure compared to people in the 30-34 age group. People in the 40-44 age group are 1.38 times more likely to have high blood pressure than people in the 30-34 age group. People in the 45-49 age group are 1.50 times more likely to have high blood pressure than people in the 30-34 age group. People in the 50-54 age group are 1.95 times more likely to have high blood pressure than people in the 30-34 age group. People in the 55-59 age group are 1.92 times more likely to have high blood pressure than people in the 30-34 age group. People in the 60-64 age group are 1.81 times more likely to have high blood pressure than people in the 30-34 age group. Furthermore, we notice that the older the individual, the more likely he/she is to have high blood pressure. This could be explained by the fact that the older you get, the more tired your body becomes and the less vigorous your heart is in circulating blood. These results confirm the work done by (Yahia-Berrouiguet et al., 2011) in Algeria and (Ratovoson et al., 2014) in Madagascar. Similar results were also obtained by (Wagner et al., 2008) in France following the Mona Lisa study.

Women are 1.34 times more likely to have hypertension than men. This could be explained by the frequent hormonal changes in women during pregnancy or menopause. Similar results have been obtained by (Frérot et al., 1999) in France. People living in the south of Benin are 1.40 times more likely to have hypertension than people living in the north of Benin. People living in the centre of Benin have a 1.56 times more risk of developing hypertension compared to people living in the north of Benin. This could be explained by the fact that the southern and central parts of Benin are more urbanised than the northern part of Benin. People with a secondary school education have 1.15 times the risk of having hypertension compared to people with no education. This can be explained by the fact that people with no education are less likely to have a rich or average standard of living than people with secondary education.

Poor people are 1.15 times more likely to have high blood pressure than very poor people. People with a middle standard of living are 1.17 times more likely to have high blood pressure than the very poor. Wealthy people have a 1.41 times more risk of developing hypertension than very poor people. The very rich are 1.55 times more likely to have hypertension than the very poor. Note that the higher the socio-economic status of the individual, the higher the risk of having hypertension. This result could be explained in our context by the fact that people with a high standard of living have dietary habits containing more fat or do less physical activity due to the existence of means of transport. People with diabetes are 2.04 times more likely to have high blood pressure than people without diabetes. This can be explained by poor lifestyle, increased physical inactivity, weight gain and poor diet in people with diabetes. Thus, we can say that the determinants of hypertension in the population aged 30 to 64 years in Benin are: age, gender, region, education level, standard of living and diabetes.

4.2.1 ***Estimation of models by gender***

4.2.1.1 Choice of explanatory variables

As for the general model, we first estimated a logit model and a probit model and then chose the best model based on the AIC criterion: the probit model. For the estimation of the probit model, two different estimates were made to give the best possible prediction of the explanatory factors of hypertension. Model 1 consists of all explanatory variables; model 2 is obtained from stepwise regression

Table 7: Model choice tests

Models	**Men's Model**		**Women's Model**	
	Resid.Dev	**AIC**	**Resid.Dev**	**AIC**
Model 1	2897,8	2,945,798	2944,6	2986,56
Model 2	2898,6	2,942,563	2954,5	2,980,495

Source: Authors, 2023

In both cases, when comparing the AIC of each model, we notice that model 2 has the lowest AIC (2942.563 and 2980.495). Thus, the best model retained for the prediction of our variable of interest is model 2 in both cases

4.2.1.2 ***Regression results***

Table 8 - Probit estimation results by gender

Variables	Male Model			Female Model		
	Coefficient	Odds Ratio	p-value	Coefficient	Odds Ratio	p-value
Age (reference = 30-34 years)						
35-39 years	0.1239	1.1319	0.1516	0.1449	1.156	0.0381*
40-44 years	0.243	1.275	0.0068**	0.3847	1.4692	4,055e-07***

45-49 years	0.3805	1.463	1,966e-05***	0.4339	1.5432	1,039e-08***
50-54 years	0.6327	1.8828	3,871e-11***			
55-59 years	0.6277	1.8734	2,521e-09***			
60-64 years old	0.5693	1.767	2,785e-06***			
Occupancy (reference = Occupied)						
Unoccupied		0.921.1844	0.1031			
Place of residence (reference = Urban)		0.9790.9067	0.1109			
Region (reference = North)						
South	0.3432	1.4094	6,012e-06***	0.3422	1.408	2,592e-06***
Centre	0.4531	1.5732	6,473e-11***	0.4089	1.5052	4,569e-09***
Instruction (reference = No instruction)						
Primary	0.0675	1.0698	0.3238			
Secondary	0.2529	1.2878	0.0009***			
Superior	-0.243	0.7842	0.0653.			
Marital status (reference = Never in union)						
Married	0.1979	1.2189	0.254			
Life with a partner	0.4586	1.5819	0.0110*			
Widower	0.3018	1.3522	0.2886			
Divorced	0.5083	1.6625	0.0646			
Separate	0.0966	1.1014	0.672			
Standard of living (reference = very poor)						
Poor	0.1654	1.1799	0.0781.	0.0845	1.0882	0.3553
Medium	0.2041	1.2264	0.0301*	0.077	1.08	0.4165
Rich	0.3421	1.4079	0.0002***	0.3232	1.3816	0.0003***
Very rich	0.404	1.4978	5,914e-05***	0.4818	1.619	3,185e-07***
Diabetes (reference = No)						
Yes	0.9375	2.5535	1,521e-06***	0.4788	1.6142	0.0126*

Source: Authors, 2023
Not significant ; (.) 10% ; (*) 5% ; (**) 1% ; (***) 0.1%.

4.2.1.3 Relevance of the model

In both the male and female models, the D/v value is very close to 1. Furthermore, the Chi-square probabilities of the Hosmer-Lemeshow tests, the Pearson residuals and the deviance residuals are all above the 5% threshold, so the model fits the data well. Thus, the model is relevant.

Table 9 - Relevance of the probit model

	Significance criterion	
Test	**Men's model**	**Women's model**
Rule of thumb	D/v = 0.7991627	D/v =0.9487781
Hosmer-Lemeshow test	Pr(Chi2)=0.950	Pr(Chi2)=0.469
Pearson's residual test	Pr(Chi2)=0.4395	Pr(Chi2)=0.5330
Residual test for deviance	Pr(Chi2)= 1	Pr(Chi2)=0.9797

Source: Authors, 2023

4.2.1.4 Quality of the model

Table 10 - Model quality

Test	**Values**	
	Men's model	**Women's model**
Error rate	0.1573	0.2024
The area under the ROC curve	0,7142	0.6712

Source: Authors, 2023

In both the male and female models, the error rate of the estimated model is less than 0.5, so the model is of good quality. In addition, the area under the ROC curve of both models (0.7142 and 0.6712) is greater than 0.60, so the model has good predictive quality.

4.2.1.5 Interpretation of Results

When we move on to the gender models, as in the overall model, age, region, standard of living and diabetic status have a significant effect on hypertension at the 5% threshold and are found to be explanatory factors for both men and women. However, we note that education and marital status are explanatory factors for hypertension in men only. Women aged between 35 and 49, living in the south or in the centre, who are rich or very rich and diabetic, are more likely to have high blood pressure. Men aged 30 to 69, married with at least secondary education and having the same characteristics as women are at greater risk of developing hypertension.

4.2.1.6 Hypothesis testing

Table 11 - Hypothesis Testing

Hypothesis	Conclusion
H1: Socio-demographic, economic and metabolic factors are the factors that influence the prevalence of hypertension	Validated
H2: Women who are older, married, wealthy and diabetic are most likely to have hypertension	Validated
H3: People with hypertension are a heterogeneous group by gender	Validated

Source: Authors, 2023

In view of the results of the analyses, all our hypotheses are validated.

4.3 Discussion

This study investigated the prevalence and drivers of hypertension in Benin. The prevalence of hypertension in our population (17.9%) is almost similar to that found in Côte d'Ivoire by (Sackou et al., 2019), which was 18.3%. Females are 1.3454 times more likely to have high blood pressure than males. These results confirm the work done by (Yahia-Berrouiguet et al., 2011) in Algeria and (Ratovoson et al., 2014) in Madagascar. Similar results were also obtained by (Wagner et al., 2008) in France following the Mona Lisa study; women are 1.34 times more likely to have hypertension than men. This could be explained by the frequent hormonal changes in women during pregnancy or menopause. Similar results have been obtained by (Frérot et al., 1999) in France.

People living in the south of Benin are 1.40 times more likely to have hypertension than people living in the north of Benin. People living in the centre of Benin have a 1.56 times more risk of developing hypertension compared to people living in the north of Benin. This could be explained by the fact that the southern and central parts of Benin are more urbanised than the northern part of Benin. This result could be explained in our context by the fact that people with a high standard of living have dietary habits containing more fat or do less physical activity due to the existence of means of transport. People with diabetes are 2.04 times more likely to have high blood pressure than people without diabetes. This can be explained by poor lifestyle, increased physical inactivity, weight gain and poor diet in people with diabetes.

4.4 Limitations of this Study
The lack of data on variables such as BMI, obesity, heredity of hypertension, alcoholism, smoking and many other variables did not allow us to draw conclusions on these risk factors present in other studies.

4.5 Operational recommendations
At the end of this study and in view of the variables that explain the factors of the prevalence of hypertension, concrete actions must be implemented by the political authorities and the populations of Benin to better prevent and reduce the risks and deaths caused by this disease. Thus, we make the following suggestions.

For the Ministry of Health, this will involve: Implementation of nationwide high blood pressure education and awareness programmes, training health personnel for this purpose, making funds available for this purpose, launch nationwide screening campaigns.

For the population of Benin, it will be an issue to: pay attention to one's heart health, not neglect heart health, especially when diabetic and in old age, and approach the health staff as soon as for any unusual signs, even the most trivial ones, take care of one's lifestyle (healthy and balanced diet, regular physical activity) and make quarterly visits to health centres to ensure her well-being.

5.0 Conclusion
The aim of this study was to determine the explanatory factors of arterial hypertension (AH) in people aged 30 to 64 in Benin. The results of this analysis reveal that age, gender, region, level of education, standard of living and diabetic status are factors influencing the prevalence of hypertension. Specifically, age, region, standard of living and diabetic status were found to have a significant effect on hypertension at the 5% threshold and thus to be explanatory factors for both men and women. On the other hand, education and marital status were found to be explanatory factors for hypertension in men only. Gender models also show that these explanatory factors vary from men to women. Marginal effects analysis reveals that diabetic status and advanced age are the main factors in the presence of hypertension in our study population.

Furthermore, the lack of data on certain variables such as BMI, obesity, heredity of hypertension, alcoholism, smoking and many other variables prevented us from drawing conclusions on these risk factors present in other studies.

Future research could extend the study to a wider sample of factors and examine other potential factors, such as the variables mentioned above, for an even deeper understanding of this issue.

In view of these results, we suggest that decision-makers educate and raise awareness of the risk factors for hypertension. We also suggest that they make the diagnosis and treatment of hypertension easy and accessible to the entire population. The general public should pay particular attention to the heart health of the elderly and diabetics.

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References
[1] Abbou, A., & El Akhrif, R. (2016). Experimental DSpace analysis of three-phase SEIG used in a wind turbine. *2016 International Renewable and Sustainable Energy Conference (IRSEC)*, pp. 414–419.
[2] Berraho, M., Rhazi, K., BENSLIMANE, A., Youness, E. A., Bendahhou, K., & Nejjari, C. (2009). Study of the knowledge of behavioural risk factors for cancer in the Moroccan population. *Revue D'Epidemiologie Et De Sante Publique - REV EPIDEMIOL SANTE PUBL*, *57*. https://doi.org/10.1016/j.respe.2009.02.053

[3] Cooper, F. (2001). Does the concept of globalisation serve a purpose? A historian's perspective. *International Criticism*, *10*(1), 101–124. https://doi.org/10.3917/crii.010.0101

[4] Dauphinot, V., Naudin, F., Guéguen, R., Perronnin, M., & Sermet, C. (2008). Gaps between declared and diagnosed morbidity. L'exemple de l'obésité, de l'hypertension artérielle et de l'hypercholestérolémie. *Revue française des affaires sociales*, *1*, 15-27. https://doi.org/10.3917/rfas.081.0015

[5] Forouzanfar, M. H., Liu, P., Roth, G. A., Ng, M., Biryukov, S., Marczak, L., Alexander, L., Estep, K., Hassen Abate, K., Akinyemiju, T. F., Ali, R., Alvis-Guzman, N., Azzopardi, P., Banerjee, A., Bärnighausen, T., Basu, A., Bekele, T., Bennett, D. A., Biadgilign, S., ... Murray, C. J. L. (2017). Global Burden of Hypertension and Systolic Blood Pressure of at Least 110 to 115 mm Hg, 1990-2015. *JAMA*, *317*(2), 165-182. https://doi.org/10.1001/jama.2016.19043

[6] Frérot, L., Le Fur, P., Le Pape, A., & Sermet, C. (1999). *L'hypertension artérielle en France: Prévalence et prise en charge thérapeutique* (N° 484; p. 209).

[7] Houenassi, M. D., David, D., Codjo, L. H., Attinsounon, A. C., Alassani, A., Ahoui, S., Dovonou, A. C., Adoukonou, T. A., Dohou, S. H. M., Wanvoegbe, A., & Agbodande, A. (2016). Management of hypertensive patients in the city of Cotonou (Benin) in 2011: Knowledge attitudes and practices of general practitioners. *Cardiovascular Journal of Africa*, *27*(4), e1-e6. https://doi.org/10.5830/CVJA-2015-094

[8] Inamo, J. (2008). *Epidemiological aspects of hypertension in the Antilles-Guyane* [These de doctorat]. Toulouse 3.

[9] Katchunga, P. B., M'buyamba-Kayamba, J.-R., Masumbuko, B. E., Lemogoum, D., Kashongwe, Z. M., Degaute, J.-P., Kabinda, J. M., & M'Buyamba-Kabangu, J.-R. (2011). [Hypertension in the adult Congolese population of Southern Kivu: Results of the Vitaraa Study]. *Presse Medicale (Paris, France: 1983)*, *40*(6), 315-323. https://doi.org/10.1016/j.lpm.2010.10.036

[10] Khot, U. N., Khot, M. B., Bajzer, C. T., Sapp, S. K., Ohman, E. M., Brener, S. J., Ellis, S. G., Lincoff, A. M., & Topol, E. J. (2003). Prevalence of conventional risk factors in patients with coronary heart disease. *JAMA*, *290*(7), 898-904. https://doi.org/10.1001/jama.290.7.898

[11] Lang, T., Bureau, J. F., Degoulet, P., Salah, H., & Benattar, C. (1983). Blood pressure, coffee, tea and tobacco consumption: An epidemiological study in Algiers. *European Heart Journal*, *4*(9), 602-607. https://doi.org/10.1093/oxfordjournals.eurheartj.a061531

[12] Macia, E., Duboz, P., & Gueye, L. (2015). Hypertension in Dakar: Prevalence, knowledge, treatment and control. *Bulletin of the Society of Exotic Pathology*, *108*(1), 49-56. https://doi.org/10.1007/s13149-014-0369-2

[13] Mills, K. T., Bundy, J. D., Kelly, T. N., Reed, J. E., Kearney, P. M., Reynolds, K., Chen, J., & He, J. (2016). Global Disparities of Hypertension Prevalence and Control: A Systematic Analysis of Population-Based Studies From 90 Countries. *Circulation*, *134*(6), 441–450. https://doi.org/10.1161/CIRCULATIONAHA.115.018912

[14] Ngombe, L. K., Cowgill, K., Monga, B. B., Ilunga, B. K., Stanis, W. O., & Numbi, O. L. (2015). Prevalence of hypertension in the population of millers in the city of Lubumbashi, Democratic Republic of Congo. *The Pan African Medical Journal*, *22*(152), Art. 152. https://doi.org/10.11604/pamj.2015.22.152.6677

[15] WHO. (2022). *Deaths from non-communicable diseases are on the rise in Africa*. WHO Regional Office for Africa.

[16] World Health Organization. (2013). *Global overview of hypertension: A silent killer causing a global public health crisis: World Health Day 2013* (WHO/DCO/WHD/2013.2). World Health Organization.

[17] World Health Organization. (2015). *Final report of the non-communicable disease risk factor surveillance survey*.

[18] Ratovoson, R., Rasetarinera Rabarisoa, O., Rogier, C., Piola, P., & Pacaud, P. (2014). Hypertension in rural adults in Moramanga, Madagascar. *Journal of Epidemiology and Public Health*, *62*(5), S229. https://doi.org/10.1016/j.respe.2014.06.187

[19] Rosengren, A., Hawken, S., Ounpuu, S., Sliwa, K., Zubaid, M., Almahmeed, W., Blackett, K., Sitthi-amorn, C., Sato, H., & Yusuf, S. (2004). Association of psychosocial risk factors with risk of acute myocardial infarction in 11 119 cases and 13 648 controls from 52 countries (the INTERHEART study): Case-control study. *Lancet*, *364*, 953-962. https://doi.org/10.1016/S0140-6736(04)17019-0

[20] Sackou, J. K., Tiadé, M. L., Hounsa, A. A., Malik, S. K., Coulibaly, M., Desquith, A. A., Kadjo, F. K., Agoua, S. A., Oga, S., & Kouadio, L. K. (2019). Prevalence and factors associated with hypertension in Anonkoi 3, a peri-urban area in Abidjan (Côte d'Ivoire). *Journal of Public Health in Africa*, *10*(2), 1106. https://doi.org/10.4081/jphia.2019.1106

[21] Séraphin, A., Jacques, V., Leopold, A. B., Precieux, O., Houétondji, C. L., Albert, D. C., Adébayo, A., & Léonard, F. (2016). Prevalence Of High Blood Pressure And Associated Factors In The Departments Of Borgou And Alibori In Benin In 2014. *European Scientific Journal, ESJ*, *12*(33), 235-235. https://doi.org/10.19044/esj.2016.v12n33p235

[22] Wagner, A., Arveiler, D., Ruidavets, J., Cottel, D., Bongard, V., Dallongeville, J., Ferrieres, J., Amouyel, P., & Haas, B. (2008). *Overview of hypertension in France in 2007: The Mona Lisa study. Thematic issue. Surveillance de l'hypertension artérielle en France* [N°. 49-50, p. 483-6]. Bulletin Epidémiologique Hebdomadaire, 2008,.

[23] World Health Organization. (2011). *World Health Statistics 2011* (p. 170). World Health Organization.

[24] World Health Organization. (2018). *Global action plan on physical activity 2018-2030: More active people for a healthier world*. World Health Organization.

[25] Yahia-Berrouiguet, A., Benyoucef, M., Meguenni, K., & Brouri, M. (2011). Survey on the prevalence of cardiovascular disease risk factors in Tlemcen (Algeria). *Medicine of Metabolic Diseases*, *5*(4, Supplement 1), 42-48. https://doi.org/10.1016/S1957-2557(11)70071-2