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Prevalence and Associated Risk Factors for Hypercholesterolemia and Hypertension in Morocco

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Abstract: The burden of cardiovascular diseases has declined over time in high-income countries, while it has increased in low- and middle-income countries. We aimed to determine the prevalence and associated risk factors of hypercholesterolemia and hypertension among Moroccan adults. Cross-sectional data were analyzed from 1495 adults aged ≥18 years who participated in the national 2017 STEPS survey. Data collection was based on the WHO STEPwise (STEPS) approach. Hypothesized risk factors for hypercholesterolemia and hypertension were investigated using binary logistic regression analysis with adjusted odds ratios (AOR) for confounding factors. The overall prevalence of hypercholesterolemia and hypertension was 13.0% and 27.8%, respectively. The prevalence of hypercholesterolemia ranged between 8.9% in divorced/widowed individuals and 19.0% in those with hyperglycemia. The prevalence of hypertension varied from 14.7% among subjects with normal fasting blood glucose to 47.8% among those with hyperglycemia. After adjustment for confounding variables, overweight/obesity, abdominal obesity, alcohol consumption, and hyperglycemia were associated with increased risk for hypercholesterolemia (AOR=1.7, 95%CI: 1.21-2.38, *P*=0.002; AOR=1.78; 95%CI: 1.30-2.43, *P*<0.001; AOR=1.38; 95%CI: 0.81-2.35, *P*=0.242; and AOR=1.98; 95%CI: 1.46-2.69, *P*<0.001; respectively). However, female gender, post-primary education, and divorced/widowed status were associated with slightly lower odds of hypercholesterolemia. Similarly, being overweight/obese, abdominally obese, a past smoker, and hyperglycemic were linked to greater odds of hypertension (AOR=1.8; 95%CI: 1.31-2.49, *P*<0.001; AOR=1.61; 95%CI: 1.21-2.14, *P*=0.002; AOR=5.36; 95%CI: 3.98-7.27, *P*<0.001). In contrast, post-primary education and current smoking were related to a relatively lower risk for hypertension. Several risk factors were associated with hypercholesterolemia and hypertension, including general overweight/obesity, abdominal obesity, and hyperglycemia. Although further research is recommended to investigate the role of various risk factors in the development of hypercholesterolemia and hypertension, our findings underscore the need for urgent public health interventions to prevent and control these diseases.

Keywords: Cardiovascular diseases, hypercholesterolemia, hypertension, risk factors, STEPS survey

Introduction

The World Health Organization (WHO) estimates that non-communicable diseases (NCDs) are the primary cause of death worldwide, resulting in an estimated 41 million deaths (74%) annually.[1] Of these, 38% are attributable to cardiovascular diseases (CVDs), and over 17 million are premature deaths (under-70 deaths).[2] Therefore, tracking the development, patterns, and risk of NCDs is a crucial public health concern for both industrialized and developing nations.[1]

Countries with low or middle income (LMICs) account for 86% of deaths from NCDs [1]. By 2027, Africa's NCD burden is expected to rise by 27%, whereas Southeast Asia and the Western Pacific will account for the largest absolute numbers of NCD-related deaths[3]. In Morocco, a lower-middle-income country in North Africa, 80% of all deaths in 2016 were caused by NCDs,[4] which is one of the highest NCD mortality rates in the Eastern Mediterranean Region. Cardiovascular diseases (38%), cancers (14%), diabetes (6%), and chronic respiratory diseases (4%) were the most common causes of death in the country.[4]

Moreover, a recent systematic review showed alarmingly high rates of CVDs among Moroccan population, with ischemic heart disease and stroke as major causes of mortality (31.0% and 22.5%, respectively). The leading risk factors for CVDs were tobacco smoking (45-50%), followed by physical inactivity (21.1%) and hypertension (25.3%) [5].

Unhealthy diets, physical inactivity, and the use of tobacco and alcohol are commonly associated with elevated blood lipids, blood pressure, blood sugar, and obesity. All these factors significantly increase the risk of CVDs, the leading NCDs responsible for premature death worldwide[1,6]. While previous studies have focused on NCD patterns in high-income countries, the applicability of these findings to LMICs, including Morocco, remains uncertain[7]. Thus, conducting more research in LMICs is crucial to establishing causal relationships, gaining a deeper understanding of NCD risk factors, and determining how behaviors and patterns evolve over time.

Furthermore, hypercholesterolemia and high blood pressure are well documented as risk factors for developing CVDs elsewhere[8,9] but little is known about their prevalence and associated factors in Morocco, particularly in some densely populated areas such as Casablanca-Settat and Rabat-Salé-

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Kenitra regions. Thus, the purpose of our study was to estimate the prevalence of hypercholesterolemia and hypertension in a large sample of Moroccan adults and to investigate its association with different sociodemographic, behavioral, and health factors.

Materials and Methods

Study design and participants

In this study, we used data from the national cross-sectional survey on risk factors for NCDs (Morocco STEPS survey). The survey was carried out from June 2017 to February 2018 among adults aged 18 years or older living in the 12 regions of the country, including Rabat-Salé-Kenitra and Casablanca-Settat regions. The participants were randomly selected using a multistage stratified and geographically clustered sampling design.

Data collection

A team of trained investigators collected data using the WHO STEPwise (STEPS) method to monitor the risk of chronic non-communicable diseases. [10] Interviews and measurements were performed at the participants' dwellings according to three standardized stages (STEPs):

Using a culturally modified and pre-tested version of the WHO STEPS questionnaire, Step 1 included face-to-face interviews to collect information on sociodemographic and behavioral factors, medical history, fruit and vegetable intake, physical activity, alcohol use, and smoking history. The following behaviors were considered as risk factors for NCDs: i) present and past tobacco use; ii) current alcohol intake; iii) insufficient fruit and vegetable consumption (less than five servings per day);[11] and iv) physical inactivity.[12]

In Step 2, physical measurements were taken with standardized tools and procedures. The computerized, automatic blood pressure monitor was used to measure blood pressure. After at least fifteen minutes of rest in a seated position, three measurements of blood pressure were taken on the patient's left upper arm. Between each reading, the participants took a three-minute break. The final blood pressure reading was calculated using the average of the three readings. Hypertension was defined as a systolic blood pressure above 140 mmHg or a diastolic blood pressure above 90 mmHg or the use of antihypertensive medication, as reported by the participant [13]. Body mass index (BMI) and waist circumference (WC) were determined using standard equipment. Each participant's weight status was identified afterwards as follows: underweight (BMI < 18.5 kg/m^2), normal weight (18.5 kg/m^2 ≤ BMI < 25 kg/m^2), overweight (25 kg/m^2 ≤ BMI < 30 kg/m^2), and obese (BMI ≥ 30 kg/m^2) based on the WHO criteria.[14] Abdominal obesity was defined based on the NCEP ATP III criteria (WC > 102 cm for men and > 88 cm for women).[15]

Biochemical measurements, including total cholesterol and fasting blood sugar (FBG) following a 12-hour fast, were part of Step 3. Hypercholesterolemia was defined as total cholesterol ≥5 mmol/L [16], while hyperglycemia was defined as FBG ≥6.1 mmol/L[17]. Self-reported history of diabetes or hypercholesterolemia with a prescription for medication from a physician was also considered as a criterion for these variables.

Ethical considerations

The survey protocol was approved by the Biomedical Research Ethics Committee of the Faculty of Medicine and Pharmacy in Rabat, Morocco. Before data collection, the objectives and methods of the survey were explained to all targeted participants, and their written consent was acquired.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) software (version 20.0; IBM Corp, Armonk, NY, USA) was used to conduct statistical analyses. Each variable's normality was examined using the Kolmogorov-Smirnov test. Descriptive statistics are used to express data as proportions and 95% confidence intervals (CIs) or as medians and interquartile ranges (IQR: 25th-75th percentile). Differences between proportions and medians of different groups were assessed by the Chi-square test and the Kruskal-Wallis test, respectively. Binary logistic regression analysis was performed to explore the association of hypertension and hypercholesterolemia with various sociodemographic, behavioral, and health factors using adjusted odds ratios for confounding factors. We controlled for stratification and clustering in these regression models by including strata and cluster variables (age, sex, and place of residence) as covariates. A *P*-value of <0.05 was considered statistically significant.

Results and Discussion

Data from 1495 adults involved in the survey were included in our analyses, with a median age of 46 years, 63.3% were female, 64.9% were overweight or obese, 70.0% lived in urban areas, and 30.9% had more than primary education. Approximately one third of participants (28.0%) were physically inactive, 58.5% had insufficient fruit and vegetable consumption (<5 servings/day), 9.4% were current smokers, 8.0% reported that they drink or drank alcohol at some point in their lifetime, and 31.0% had high fasting blood glucose level (Table 1).

Table 1 Characteristics of the study population

Variables	Total (N=1495)	Men (n=549)	Women (n=946)	*P*-value
Age (years)	46.0(35.0-59.0)	48.0(38.0-61.0)	45.0(34.0-57.0)	0.003
BMI (Kg/m^2)	26.7(23.4-30.1)	25.3(21.9-28.0)	27.9(24.2-31.3)	0.818
WC (cm)	93.0(84.0-101.0)	91.0(84.0-99.0)	94.0(85.0-103.0)	0.915
Weight status				
Underweight	3.1(2.3-4.0)	3.6(2.2-5.3)	2.7(1.7-3.8)	<0.001
Normal weight	32.0(29.6-34.4)	42.3(38.5-46.5)	26.1(23.4-29.2)	
Overweight	39.5(36.9-42.0)	40.5(36.5-44.7)	38.9(35.8-41.9)	
Obesity	25.4(23.3-27.6)	13.5(10.6-16.2)	32.3(29.3-35.2)	

Abdominal obesity				
No	49.3(46.7-51.8)	81.4(77.9-84.9)	30.7(27.8-33.7)	<0.001
Yes	50.7(48.2-53.3)	18.6(15.1-22.1)	69.3(66.3-72.2)	
Place of residence				
Rural	30.0(27.6-32.2)	33.5(29.7-37.5)	28.0(25.2-30.9)	0.015
Urban	70.0(67.8-72.4)	66.5(62.5-70.3)	72.0(69.1-74.8)	
Education level				
None (illiterate)	46.8(44.2-49.4)	34.2(30.2-38.3)	54.0(50.8-57.3)	<0.001
Primary education	22.3(20.3-24.5)	27.0(23.1-30.8)	19.7(16.8-22.1)	
Secondary education	22.7(20.6-24.8)	25.9(22.2-29.7)	20.9(18.3-23.7)	
Higher education	8.2(6.8-9.6)	12.9(10.2-15.8)	5.4(4.0-6.9)	
Adequate fruit and vegetable consumption				
Yes	41.5(39.1-43.9)	44.3(40.1-48.3)	39.9(36.8-43.2)	0.053
No	58.5(56.1-60.9)	55.7(51.7-59.9)	60.1(56.8-63.2)	
Physical activity level				
Active	72.0(69.8-74.2)	75.2(71.4-78.9)	70.1(67.1-72.9)	0.019
Inactive	28.0(25.8-30.2)	24.8(21.1-28.6)	29.9(27.1-32.9)	
Alcohol consumption				
No	92.0(90.6-93.3)	80.0(76.7-83.2)	98.9(98.3-99.6)	<0.001
Yes	8.0(6.7-9.4)	20.0(16.8-23.3)	1.1(0.4-1.7)	
Smoking				
Never	83.1(81.1-85.1)	55.9(51.7-60.1)	98.9(98.2-99.6)	<0.001
Past	7.4(6.1-8.9)	19.3(16.2-22.8)	0.5(0.1-1.1)	
Current	9.4(7.9-10.9)	24.8(21.5-28.6)	0.5(0.1-1.1)	
High fasting blood glucose				
No	69.0(66.6-71.3)	68.7(64.5-72.5)	69.1(66.3-72.2)	0.448
Yes	31.0(28.7-33.4)	31.3(27.5-35.5)	30.9(27.8-33.7)	

Data are presented as median and interquartile range (25th-75th percentile) for continuous variables, and as proportion and 95% confidence interval (95% CI) based on 1000 bootstrap samples for categorical variables.

The prevalence of hypercholesterolemia and hypertension among the study population was 13.0% and 27.8%, respectively. The proportion of individuals with hypercholesterolemia and hypertension was higher in individuals with overall or abdominal obesity and elevated fasting blood glucose compared to those in groups categorized by gender, age, place of residence, educational level, marital status, fruit and vegetable intake, and physical activity level. Although it is difficult to compare various groups, these results show that sociodemographic and behavioral factors may be not as strongly associated with high total cholesterol and high blood pressure as obesity and hyperglycemia. Elevated total cholesterol level tended to be more common among alcohol drinkers than non-drinkers while high blood pressure was more prevalent in former smokers than current or never-smokers (Table 2).

Table 2. Prevalence of hypercholesterolemia and hypertension among adults living in Rabat-Salé-Kenitra and Casablanca-Settat regions (Morocco STEPS 2017)

Variables/ Categories	N/n	Hypercholesterolemia (%)	Hypertension (%)
All	1495	13.0	27.8
Gender			
Men	549	14.2	27.4
Women	946	12.6	28.0
Age (years)			
18-29	227	12.8	27.8
30-44	465	13.5	27.9
45-59	452	13.1	27.6

60-69	212	13.2	26.0
≥70	139	12.9	30.3
Residence			
Rural	449	13.8	28.6
Urban	1046	12.9	27.4
Education level			
None (illiterate)	699	14.0	28.3
Primary education	334	12.5	30.6
Secondary education	340	12.2	25.1
Higher education	122	13.1	24.1
Marital status			
Single	164	12.2	23.7
Married	1105	14.2	28.6
Divorced/widowed	225	8.9	26.8
Weight status			
Underweight	46	2.2	33.3
Normal weight	479	10.2	19.0
Overweight	590	15.1	28.3
Obesity	380	15.3	35.8
Abdominal obesity			
No	737	9.9	22.6
Yes	758	16.4	31.9
Adequate fruit and vegetable consumption			
Yes	620	14.0	25.8
No	875	12.6	29.3
Physical activity level			
Active	1076	13.4	27.9
Inactive	419	12.6	27.4
Alcohol consumption			
No	1375	12.8	27.9
Yes	120	17.5	25.6
Smoking status			
Never	1243	13.0	27.5
Past	111	13.5	36.5
Current	141	14.2	23.9
High fasting blood glucose			
No	1031	10.6	14.7
Yes	464	19.0	47.8

According to the adjusted logistic regression model, hypercholesterolemia was positively associated with being overweight/obese (AOR = 1.7; 95%CI: 1.21-2.38), abdominally obese (AOR = 1.78; 95%CI: 1.30-2.43), alcohol drinker (AOR = 1.38; 95%CI: 0.81-2.35), and having high fasting blood glucose (AOR = 1.98; 95%CI: 1.46-2.69). However, it tended to be inversely associated with female gender (AOR = 0.87; 95%CI: 0.64-1.18), divorced/widowed status (AOR = 0.44; 95%CI: 0.67-3.09), and post-primary education (AOR = 0.79; 95%CI: 0.52-1.19). The odds of hypertension were also higher among individuals who were overweight/obese (AOR = 1.8; 95%CI: 1.31-2.49), abdominally obese (AOR = 1.61; 95%CI: 1.21-2.14), former smokers (AOR = 1.19; 95%CI: 0.63-1.95), low consumers of fruits and vegetables (<5 servings/day) (AOR = 1.19; 95%CI: 0.63-1.95), and hyperglycemic (AOR = 5.36; 95%CI: 3.98-7.27) (Table 3).

Table 3. Association of hypercholesterolemia and hypertension with sociodemographic, behavioral and health factors in adults living in Rabat-Salé-Kenitra and Casablanca-Settat regions (Morocco STEPS 2017)

Variables	Hypercholesterolemia				Hypertension		
	AOR	95%CI	*P*-value		AOR	95%CI	*P*-value
Gender							
Men	Ref.				Ref.		
Women	0.87	0.64-1.18	0.378		1.03	0.77-1.38	0.824
Age groups (years)							
18-44	Ref.				Ref.		
≥ 45	1.03	0.76-1.39	0.840		0.99	0.75-1.31	0.951
Residence							
Rural	Ref.				Ref.		
Urban	0.93	0.67-1.29	0.675		0.98	0.71-1.36	0.926
Education level							
None (illiterate)	Ref				Ref.		
Primary education	0.94	0.61-1.43	0.757		1.18	0.83-1.70	0.345
>Primary education	0.79	0.52-1.19	0.265		0.89	0.62-1.28	0.531
Marital status							
Single	Ref.				Ref.		
Married	1.17	0.47-1.44	0.502		1.12	0.43-2.92	0.823
Divorced/widowed	0.44	0.67-3.09	0.347		1.05	0.37-2.96	0.930
Weight status							
Non-overweight	Ref.				Ref.		
Overweight/obesity	1.70	1.21-2.38	0.002		1.80	1.31-2.49	<0.001
Abdominal obesity							
Without	Ref.				Ref.		
With	1.78	1.30-2.43	<0.001		1.61	1.21-2.14	0.001
Adequate fruit and vegetable consumption							
Yes	Ref.				Ref.		
No	0.88	0.65-1.20	0.418		1.19	0.63-1.95	0.229
Physical activity level							
Active	Ref.				Ref.		
Inactive	0.96	0.68-1.36	0.816		0.97	0.71-1.32	0.849
Alcohol consumption							
No	Ref.				Ref.		
Yes	1.38	0.81-2.35	0.242		1.11	0.81-2.35	0.712
Smoking status							
Never	Ref.				Ref.		
Past	1.07	0.57-2.01	0.829		1.51	0.89-2.59	0.128
Current	1.02	0.58-1.79	0.957		0.83	0.50-1.37	0.461
High fasting blood glucose							
No	Ref.				Ref.		
Yes	1.98	1.46-2.69	<0.001		5.36	3.98-7.27	<0.001

Adjusted odds ratio (AOR) and 95% confidence interval (95%CI) using binary logistic regression analysis.

Prevalence and risk factors associated with hypercholesterolemia

The prevalence of hypercholesterolemia in our study population was 13%, which is consistent with the findings of some previous studies conducted in Saudi Arabia (12.5%), Iran (13.4%), and Iraq (14.2%).[18-20] Our estimate is significantly lower than that previously reported in other populations, such as the Turkish (37.5%), Lebanese (36.9%), and global population (39.0%), whereas it is greater than that observed in other studies carried out in Palestine (3.6%) and Iran (8.7%)[21,22.25]. These differences may result from disparities in socioeconomic and cultural backgrounds which can differ from one country to another. They also can be influenced by various methodological techniques and reporting systems used in these studies.

In this study, women tended to be less likely than men to have hypercholesterolemia. This finding is in line with some previous studies that found men being more likely than women to have hypercholesterolemia[18,23,26,27]. However, other studies found that women are more likely than men to have hypercholesterolemia[28]. Another study in Portugal found that the prevalence of hypercholesterolemia was roughly the same for both sexes (63.8% vs. 62.8%).[29] Our results could be explained by an increased awareness and control of cholesterol levels, as well as a reduction in dietary fat intake among women. It should be noted that a large proportion of women (65%) were overweight or obese (Table 1) and could be more sensitive than men to controlling their weight through an engagement in healthful eating patterns. Another possible explanation for the observed difference could be the influence of age and associated factors in women who were on average younger than men (45 years vs. 48 years). Several factors, including sex hormones, chromosomal differences, and other biological sex-related factors, may provide protective effects against hypercholesterolemia in women before menopause. [30] Moreover, a recent study of 542 Moroccan women found that fat consumption tended to decrease with age and the majority of them (81.5%) consumed fewer calories than the recommended daily amount[31].

Contrary to previous studies,[18,29] we observed no significant difference in the likelihood of hypercholesterolemia between different age groups. Thus, despite the epidemiological evidence indicating that serum cholesterol levels rise with ongoing age,[32] our findings highlight the need for more research to address the pathophysiological changes in cholesterol metabolism associated with aging.

Although there was a slight increase in the risk of hypercholesterolemia in rural areas compared to urban areas, the difference was not statistically significant. Even though our findings are in line with those of prior research,[33,34] other studies found that the prevalence of hypercholesterolemia was higher in urban areas than in rural ones.[35–37] These results imply that primary health care should include awareness campaigns about healthy eating habits and periodic screening for both urban and rural populations.

Our study found that the likelihood of hypercholesterolemia was inversely associated with education level. Although our results did not reach statistical significance, they are aligned with another study which did not find a significant association between hypercholesterolemia and education attainment[36]. This may indicate that people with higher education levels may be more knowledgeable about nutrition or engage in healthier habits than people with lower levels of education.

As expected, the risk of hypercholesterolemia in our study sample was significantly positively associated with both central obesity and overall overweight/obesity. These results are in line with earlier studies showing that waist circumference and body mass index are reliable predictors of hypercholesterolemia.[18, 39, 40]

Risk factors for hypercholesterolemia include unhealthy lifestyle choices like smoking, alcohol use, not exercising, and consuming inadequate amounts of fruits and vegetables.[42] The current study showed that drinking alcohol was linked to a slightly higher risk of hypercholesterolemia (AOR=1.38; 95% CI: 0.81-2.35), and that past and current smokers had a slightly higher chance of developing hypercholesterolemia than never smokers (AOR=1.07; 95% CI: 0.57-2.01, and AOR=1.02; 95% CI: 0.58-1.79, respectively). Furthermore, a surprisingly lower incidence of hypercholesterolemia was linked to low physical activity and inadequate fruit and vegetable intake. These conflicting results may be due to differences in ethnicity, color, culture, financial level, dietary habits, and access to public health care. Further research is recommended to investigate the role of lifestyle factors in the development and prevention of hypercholesterolemia.

High fasting blood glucose levels were associated with an increased risk of hypercholesterolemia. Our findings are consistent with other studies that found a positive association between hyperglycemia and hypercholesterolemia.[34, 43] Large community-based surveys have documented the co-occurrence of dyslipidemia and diabetes.[34, 44, 45] The metabolic syndrome, which affects approximately 31% of adults worldwide and is associated with a 1.5-fold increase in the risk of all-cause mortality, a two-fold increase in the risk of coronary heart disease, and a cerebrovascular disease, is largely composed of these comorbidities.[46] Therefore, reducing the short- and medium-term consequences of the disease requires vigorous pharmaceutical control of hyperglycemia and hypercholesterolemia in affected individuals, as well as routine health checkups.

Prevalence and risk factors associated with hypertension

The prevalence of hypertension (27.8%) found in this study was lower than the 33.6% reported in the 2000 study conducted by the Moroccan Ministry of Health.[47] Similarly, it is lower than that observed in some European nations, including Germany (55%), Spain (47%), the United Kingdom (42%), and Sweden (38%), as well as some North African nations, like Tunisia (47.4%),[48], and Algeria (36.9%),[49.50]. Additionally, our estimate of hypertension prevalence was greater than that of the WHO Americas Region (18%) but was similar to the average rates in the WHO African Region (27%).[51]

Previous studies have shown that sociodemographic factors such as gender,[52,53] age,[54] marital status,[55] and place of residence[56] may increase the risk for hypertension. In our study population, there was no significant association between these factors and hypertension. Such inconsistent sociodemographic differences could be attributed to the tremendous epidemiologic transition experienced by Morocco in recent years. This transition was driven by an increased prevalence of various

known risk factors for NCDs, such as sedentary behavior, low physical activity, tobacco smoking, alcohol use, and unhealthy westernized diet.[58] Moreover, to some extent, urbanized rural areas may share the environmental risk factors of urban areas. Thus, our findings underscore the need for effective public health interventions to prevent and control hypertension, regardless of gender, age, marital status, and place of residence.

In the current study, the higher education level tended to be associated with a lower risk of hypertension. Our results are aligned with other research showing a strong association between elevated blood pressure and low educational attainment. [58,59] Individuals with higher education levels may be more aware of health problems and are more inclined to adopt healthier habits, potentially preventing the onset of NCDs including hypertension. Our findings suggest that public health authorities may find it helpful to consider the importance of education in initiatives aimed at preventing and monitoring high blood pressure.

Our findings demonstrated that abdominal obesity and overweight/obesity were linked to significantly increased risk of hypertension. These results are in line with past research showing that elevated waist circumference and body mass index are reliable indicators of hypertension.[59,60] Therefore, primary care doctors should keep an eye on their patients' BMI and support weight loss. Preventing or postponing the onset of hypertension may also be accomplished through public health initiatives that support maintaining a healthy body weight through consistent exercise and a sufficient energy intake.

Physical inactivity and inadequate fruit and vegetable intake were found to be associated with an increased risk of hypertension.[61,62] In this study, participants with insufficient fruit and vegetable consumption had slightly higher odds of being hypertensive (AOR = 1.19; 95%CI: 0.63-1.95), while there was a very weak negative association between physical inactivity and hypertension (AOR = 0.97; 95%CI: 0.71-1.32). The reasons underlying the lack of significant relationships between these factors and blood pressure are unclear and need to be investigated. We hypothesize that probably after being diagnosed with prehypertension or hypertension, or other risk factors such as being overweight or obese, the study participants would have engaged in regular physical activity and healthy dietary intake based on medical advice.

Participants who reported drinking alcohol had slightly higher chances of being hypertensive. While this finding aligns with other studies suggesting that alcohol consumption is associated with an increased risk for hypertension,[63,64] it should be viewed with caution. This is because all survey participants were Muslims who are typically prohibited from drinking alcohol and may not accurately disclose their alcohol use.

Compared to never-smokers, past smokers had a higher risk of hypertension (AOR = 1.51; 95%CI: 0.89-2.59), while current smokers had marginally lower odds of being hypertensive (AOR = 0.83; 95%CI: 0.50-1.37). Despite the latter inverse relationship, our findings are aligned with previous studies indicating that smoking is a risk factor for hypertension.[59] Nevertheless, it is difficult to ascertain whether smoking causes hypertension, as this could be partly attributed to low vitamin D levels induced by tobacco smoke exposure, in addition to the effects of tobacco smoke exposure and vitamin D deficiency themselves, or to the interaction between tobacco and alcohol consumption.[65,66] More research is required to delineate the basis of the observed associations between smoking and hypertension risk in our study population.

The current study revealed a significant association between hypertension and high fasting blood glucose (AOR = 5.36; 95%CI: 3.98-7.27). Our results are consistent with previous studies suggesting that increased blood glucose levels may be linked to an increased risk of hypertension.[56,63] Although this is an observational study and it could not show causality, these findings underscore the importance of preventing and controlling hyperglycemia as a risk factor for hypertension, particularly among vulnerable groups such as obese and elderly people.

Strengths and limitations

The strengths of the current study include using the standardized methods of the WHO STEPwise approach for data collection and the large sample size that could allow reasonably accurate estimates of hypercholesterolemia and hypertension prevalence. However, this study has some limitations to be considered. Firstly, we used cross-sectional data that cannot establish causal relationships of the reported associations but only observations and hypotheses. Secondly, the relatively low proportion of men among our study population does not allow an accurate assessment of the gender effect. Thirdly, the missing information about participants' eating habits and households' socioeconomic status is needed to assess their relationships with hypercholesterolemia and hypertension. Lastly, information bias might result from the questions on self-reported demographic and lifestyle risk factors such as smoking and alcohol consumption.

Conclusion

In this study, a large proportion of participants were identified as having hypercholesterolemia (13.0%) or hypertension (27.8%). Several factors associated with hypercholesterolemia and hypertension were detected, including female sex, lower education, general overweight/obesity, abdominal obesity, inadequate fruit and vegetable intake, alcohol consumption, past smoking, and hyperglycemia. Although further research is recommended to investigate the role of various risk factors in the development of hypercholesterolemia and hypertension, our findings underscore the need for public health interventions targeting overweight/obesity, alcohol consumption, smoking, unhealthy diets, and physical inactivity to prevent and control cardiovascular diseases in the Moroccan adult population.

Ethics approval and consent to participate

The study was carried out according to the ethical principles of the World Medical Association Declaration of Helsinki and was approved by the Biomedical Research Ethics Committee of the Faculty of Medicine and Pharmacy in Rabat, Morocco. All participants provided written informed consent before data collection.

Availability of data and materials

The data used in this study are publicly available at the World Health Organization NCD Microdata Repository: https://extranet.who.int/ncdsmicrodata/index.php/catalog/544

Author's contribution

HL., HEB., SLM., NS., SM., LB., KE., HA contributed to the conception and the design of the study, HL., SLM., BM., KB., NA., HA collected the data and conducted data analysis; HL.,

BA., SLM., LB interpreted the results and wrote the manuscript. HL., SLM., NA., HA critically revised the manuscript. All authors have read and approved the final version of the manuscript.

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Conflicts of interest

All authors have no conflict of interest to disclose.

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